Augustus A. Gould

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ANNUAL

OF

SCIENTIFIC DISCOVERY:

OR,

YEAR-BOOK OF FACTS IN SCIENCE AND ART

FOR 1861.

EXHIBITING THE

MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS

IN

MECHANICS, USEFUL ARTS, NATURAL PHILOSOPHY, CHEMISTRY, ASTRONOMY, GEOLOGY, ZOOLOGY, BOTANY, MINERALOGY, METEOROLOGY, GEOGRAPHY, ANTIQUITIES, ETC.

TOGETHER WITH

NOTES ON THE PROGRESS OF SCIENCE DURING THE YEAR 1860; A LIST OF RECENT SCIENTIFIC PUBLICATIONS; OBITUARIES OF EMINENT SCIENTIFIC MEN, ETC.

EDITED BY

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NOTES BY THE EDITOR

ON THE

PROGRESS OF SCIENCE FOR THE YEAR 1860.

THE fourteenth meeting of the American Association for the Advancement of Science was held August 1–8, 1860, at Newport, R. I. — Isaac Lea, Esq., of Philadelphia, in the chair. The whole number of papers registered for presentation was 78.

The number of members in attendance was small, only 140 names appearing on the register during the continuance of the meeting. "Neither can we," says the editor of *Silliman's Journal*, in commenting on the meeting, "conceal the fact, that while many papers of marked ability were presented, the character of this meeting was not in all respects creditable to American science. A conviction prevailed among many who were present at Newport of a decadence in the scientific character of the Association, of a loss of tone, which, if not already a demoralization, threatened soon to become such."

The Association adjourned, to meet in Nashville, Tennessee, in April, 1861. The officers of the Nashville meeting are: President, F. A. P. Barnard, LL.D., President of the University of Mississippi; Vice President, Dr. Robt. W. Gibbes, of South Carolina; General Secretary, Prof. J. W. Mallet, of Mississippi; Treasurer, Dr. A. L. Elwyn, of Philadelphia.

The thirtieth annual meeting of the British Association for the Advancement of Science was held at Oxford. June, 1860, Lord Wrottesley in the chair; and was one of the most successful meetings since the foundation of the Association.

The meeting for 1861 was appointed to be held at Manchester — Mr. Fairbairn, the celebrated English engineer, being the President elect.

From the address of the President on the "Progress of Science" since the previous meeting, we make the following extracts: — "The observations of our private astronomical observers have been chiefly devoted to seven important objects: First, the observing and mapping of the smaller stars, under which term I include all those which do not form the peculiar province of the public observer; secondly,

the observations of the positions and distances of double stars; thirdly, observations, delineations, and catalogues of the nebulæ; fourthly, observations of the minor planets; fifthly, cometary observations; sixthly, observations of the solar spots, and other phenomena on the sun's disk; seventhly, occultations of stars by the moon, eclipses of the heavenly bodies, and other occasional extra-meridional observations.

"And, first, as to cataloguing and mapping the smaller stars. This means, as you know, the accurate determination by astronomical observation of the places of those objects, as referred to certain assumed fixed points in the heavens. The first Star Catalogue, worthy to be so called, is that which goes by the name of Flamsteed's, or the British Catalogue. It contains above 3000 stars, and is the produce of the labors of the first Astronomer Royal of Greenwich. About the middle of the eighteenth century, the celebrated Dr. Bradley, who also filled the post of Astronomer Royal, observed an almost equally extensive Catalogue of Stars, and the beginning of the nineteenth century gave birth to that of Piazzi of Palermo. These three are the most celebrated of what may be now termed the ancient Catalogues. About the year 1830, the attention of modern astronomers was more particularly directed to the expediency of reöbserving the stars in these three Catalogues; a task which was much facilitated by the publication of a very valuable work of the Astronomical Society, which rendered the calculations of the observations to be made comparatively easy; and, accordingly, observations were commenced and completed in several public and private observatories, from which some curious results were deduced; as, *e. g.*, sundry stars were found to be missing, and others to have what is called 'proper motion.' And now a word as to the utility of this course of observation. It is well observed by Sir John Herschel, 'that the stars are the landmarks of the universe; every well-determined star is a point of departure which can never deceive the astronomer, geographer, navigator, or surveyor.' We must have these fixed points in order to refer to them all the observations of the wandering heavenly bodies, the planets and the comets. By these fixed marks we determine the situation of places on the earth's surface, and of ships on the ocean. When the places of the stars have been registered, celestial charts are constructed; and by comparing these with the heavens, we at once discover whether any new body be present in the particular locality under observation; and thus have most of the fifty-seven small or minor planets between Mars and Jupiter been discovered. The observations, however, of these smaller stars, and the registry of their places in Catalogues, and the comparisons of the results obtained at different and distinct periods, have revealed another extraordinary fact, no less than that our own sun is not fixed in space, but that it is constantly moving forward towards a point in the constellation Hercules, at the rate, as it is supposed, of about 18,000 miles an hour, carrying with it the whole planetary and cometary sys-

tem; and if our sun moves, probably all the other stars or suns move also, and the whole universe is in a perpetual state of motion through space.

"The second subject to which the attention of private observers has been more particularly directed is that of double or multiple stars, or those which, being situated very close to one another, appear single to the naked eye, but when viewed through powerful telescopes are seen to consist of two or more stars. The measuring the angles and distances from one another of the two or more component stars of these systems has led to the discovery that many of these very close stars are, in fact, acting as suns to one another, and revolving round their common centre of gravity, each of them probably carrying with it a whole system of planets and comets, and, perhaps, each carried forward through space like our own sun. It became then a point of great interest to determine whether bodies so far removed from us as these systems observed Newton's law of gravity; and to this end it was necessary to observe the angles and distances of a great number of these double stars, scattered everywhere through the heavens, for the purpose of obtaining data to compute their orbits. This has been done, and chiefly by private observers, and the result is that these distant bodies are found to be obedient to the same laws that prevail in our own system.

"Of all the phenomena of the heavens, there are none which excite more general interest than comets, and though the larger and brighter comets naturally excite most general public interest, and are really valuable to astronomers, as exhibiting appearances which tend to throw light on the internal structure of these bodies, and the nature of the forces which must be in operation to produce the extraordinary phenomena observed, yet some of the smaller telescopic comets are, perhaps, more interesting in a physical point of view. Thus the six periodical comets, the orbits of which have been determined with tolerable accuracy, and which return at stated intervals, are extremely useful, as being likely to disclose the facts of which, but for them, we should possibly have ever remained ignorant. Thus, for example, when the comet of Encke, which performs its revolution in a period of a little more than three years, was observed at each return, it disclosed the important and unexpected fact that its motion was continually accelerated. At each successive approach to the sun it arrives at its perihelion sooner and sooner; and there is no way of accounting for this so satisfactory as that of supposing that the space in which the planetary and cometary motions are performed is everywhere pervaded by a very rarefied atmosphere or ether, so thin as to exercise no perceptible effect on the movements of massive solid bodies, like the planets, but substantial enough to exert a very important influence on more attenuated substances moving with great velocity. The effect of the resistance of the ether is to retard the tangential motion, and allow the attractive force of gravity to draw the

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body nearer to the sun, by which the dimensions of the orbit are continually contracted and the velocity in it augmented. The final result will be that, after the lapse of ages, this comet will fall into the sun; this body, a mere hazy cloud, continually flickering, as it were, like a celestial moth round the great luminary, is at some distant period destined to be mercilessly consumed. Now the discovery of this ether is deeply interesting as bearing on other important physical questions, such as the undulatory theory of light; and the probability of the future absorption of comets by the sun is important as connected with a very interesting speculation by Professor Wm. Thomson, who has suggested that the heat and light of the sun may be from time to time replenished by the falling in and absorption of countless meteors which circulate round him; and here we have a cause revealed which may accelerate or produce such an event.

"On the 1st of September last, at eighteen minutes past 11 A. M., a distinguished astronomer, Mr. Carrington, had directed his telescope to the sun, and was engaged in observing his spots, when suddenly two intensely luminous bodies burst into view on its surface. They moved side by side through a space of about 35,000 miles, first increasing in brightness, then fading away; in five minutes they had vanished. They did not alter the shape of a group of large black spots which lay directly in their paths. Momentary as this remarkable phenomenon was, it was fortunately witnessed and confirmed, as to one of the bright lights, by another observer, Mr. Hodgson, at Highgate, who, by a happy coincidence, had also his telescope directed to the great luminary at the same instant. It may be, therefore, that these two gentlemen have actually witnessed the process of feeding the sun, by the fall of meteoric matter; but, however this may be, it is a remarkable circumstance, that the observations at Kew show that on the very day, and at the very hour and minute of this unexpected and curious phenomenon, a moderate but marked magnetic disturbance took place; and a storm, or great disturbance of the magnetic elements, occurred four hours after midnight, extending to the southern hemisphere. Thus is exhibited a seeming connection between magnetic phenomena and certain actions taking place on the sun's disk, — a connection which the observations of Schwabe, compared with the magnetical records of our colonial observatories, had already rendered nearly certain.

"In chemistry I am informed that great activity has been displayed, especially in the organic department of the science. For several years past processes of substitution (or displacement of one element or organic group by another element or group more or less analogous) have been the main agents employed in investigation, and the results to which they have led have been truly wonderful; enabling the chemist to group together several compounds of comparatively simple constitution into others much more complex, and thus to imitate, up to a certain point, the phenomena which take place within the growing plant or

animal. It is not, indeed, to be anticipated that the chemist should ever be able to produce, by the operations of the laboratory, the arrangement of the elements in the forms of the vegetable cell or the animal fibre; but he may hope to succeed in preparing some of the complex results of secretion or of chemical changes produced within the living organism,—changes which furnish definite crystallizable compounds, such as the formiates and the acetates, and which he has actually obtained by operations independent of the plant or the animal. Hofmann, in pursuing the chemical investigation of the remarkable compound which he has termed *Triethylphosphine*, has obtained some very singular compound ammonias. Triethylphosphine is a body which takes fire spontaneously when its vapor is mixed with oxygen, at a temperature a little above that of the body. It may be regarded as ammonia in which an atom of phosphorus has taken the place of nitrogen, and in which the place of each of the three atoms of hydrogen in ammonia is supplied by ethyl, the peculiar hydrocarbon of ordinary alcohol. From this singular base Hofmann has succeeded in procuring other coupled bases, which, though they do not correspond to any of the natural alkalies of the vegetable kingdom, such as morphia, quinia, or strychnia, yet throw some light upon the mode in which complex bodies more or less resembling them have been formed.

"The bearing of some recent geological discoveries on the great question of the high antiquity of Man was brought before your notice at your last meeting by Sir Charles Lyell. Since that time many French and English naturalists have visited the valley of the Somme in Picardy, and confirmed the opinion originally published by M. Boucher de Perthes, in 1847, and afterwards confirmed by Mr. Prestwich, Sir C. Lyell, and other geologists, from personal examination of that region. It appears that the position of the rude flint-implements, which are unequivocally of human workmanship, is such, at Abbeville and Amiens, as to show that they are as ancient as a great mass of gravel which fills the lower parts of the valley between those two cities, extending above and below them. This gravel is an ancient fluviatile alluvium by no means confined to the lowest depressions (where extensive and deep peat-mosses now exist), but is sometimes also seen covering the slopes of the boundary hills of chalk at elevations of eighty or one hundred feet above the level of the Somme. Changes, therefore, in the physical geography of the country, comprising both the filling up with sediment and drift, and the partial reëxcavation of the valley, have happened since old river-beds were, at some former period, the receptacles of the worked flints. The number of these last, already computed at above fourteen hundred in an area of fourteen miles in length and half a mile in breadth, has afforded to a succession of visitors abundant opportunities of verifying the true geological position of the implements.

"The old alluvium, whether at higher or lower levels, consists not

only of the coarse gravel with worked flints above mentioned, but also of super-imposed beds of sand and loam, in which are many fresh-water and land shells, for the most part entire, and of species now living in the same part of France. With the shells are found bones of the mammoth and an extinct rhinoceros, *R. tichorhinus*, an extinct species of deer, and fossil remains of the horse, ox, and other animals. These are met with in the overlying beds, and sometimes also in the gravel where the implements occur. At Menchecourt, in the suburbs of Abbeville, a nearly entire skeleton of the Siberian rhinoceros is said to have been taken out about forty years ago, a fact affording an answer to the question often raised, as to whether the bones of the extinct mammalia could have been washed out of an older alluvium into a newer one, and so redeposited and mingled with the relics of human workmanship.

"The exploration of caverns, both in the British Isles and other parts of Europe, has in the last few years been prosecuted with renewed ardor and success, although the theoretical explanation of many of the phenomena brought to light seems as yet to baffle the skill of the ablest geologists. Dr. Falconer has given us an account of the remains of several hundred hippopotami, obtained from one cavern, near Palermo, in a locality where there is now no running water. The same palæontologist, aided by Colonel Wood, of Glamorganshire, has recently extracted from a single cave in the Gower peninsula of South Wales a vast quantity of the antlers of a reindeer, perhaps of two species of reindeer, both allied to the living one. These fossils are most of them shed horns; and there have been already no less than eleven hundred of them dug out of the mud filling one cave.

"In the cave of Brixham, in Devonshire, and in another near Palermo, in Sicily, flint implements were observed by Dr. Falconer, associated in such a manner with the bones of extinct mammalia, as to lead him to infer that man must have coexisted with several lost species of quadrupeds; and M. de Vibraye has also this spring called attention to analogous conclusions, at which he has arrived by studying the position of a human jaw with teeth, accompanied by the remains of a mammoth, under the stalagmite of the Grotto d'Arcis, near Troyes, in France."

An international congress of persons interested in chemical pursuits was held at Carlsruhe, Germany, in September, 1860, Dumas of Paris being in the chair. The attendance was large, and although a great majority of those present, as might have been expected, were Germans, yet representatives from many other parts of the world were not wanting. The proceedings lasted some days, and a detailed account of the deliberations is to be published.

Among the questions submitted for general discussion were the following: —

Would it be judicious to establish a difference between the term *atom* and *molecule*?

Is the idea of equivalents empirical and independent of the idea of atom or molecule?

Would it be desirable to place chemical notation in harmony with the progress of science?

The last question was answered with much emphasis in the affirmative; but M. Dumas thought the time had not yet come to adopt a definite method of notation. He wished, however, to see at once added to the system of Berzelius the modifications which were rendered necessary by the recent progress of organic chemistry. One important point to which he called the attention of the congress was the necessity of looking at the requirements of instruction: in this respect unity in language and theory seemed to be most desirable. The President concluded by expressing the hope that the meeting would not be the last, and that next year the European chemists would again meet to discuss some of the points of a science cultivated at present with so much ardor and success.

In the department of geographical research, the past two or three years have been periods of great activity; and especially in the exploration of Central Africa the zeal of explorers seems to have been greatly increased. "The earlier discoveries of Livingstone," says Sir R. I. Murchison, in his address before the Section of Geography and Ethnology, at the last meeting of the British Association, "have been followed by other researches of his companions and himself, which, as far as they go, have completely realized his anticipation of detecting large elevated tracts, truly *Sanatoria* as compared with those swampy, low regions near the coast, which have impressed too generally upon the minds of our countrymen the impossibility of sustaining a life of exertion in any intertropical region of Africa. The opening out of the Shire river, that grand affluent of the Zambesi, with the description of its banks and contiguous lofty terraces and mountains, and the development of the healthfulness of the tract, is most refreshing knowledge, the more so as it is accompanied by the pleasing notice that in this tract the slave-trade is unknown, except by the rare passage of a gang from other parts; whilst the country so teems with rich vegetable products, including cotton and herds of elephants, as to lead us to hope that a spirit of profitable barter, which powerfully animates the natives, may lead to their civilization, and thus prove the best means of eradicating the commerce in human beings. Whilst Livingstone was sailing to make his last venture, Captains Burton and Speke were returning from their glorious exploits into a more central and northern region of South Africa, where they had discovered two great internal lakes, or freshwater seas, each of them not less than three hundred miles in length. I may here notice, to the honor of our government, that Captain Speke, associated with another officer of the Bengal army, Captain Grant, has received £2500, to enable him to terminate his examination of the great Nyanza lake, under the equator, and we have reason to hope

that he will find the chief feeders of the White Nile flowing out from its northern extremity, and thus determine the long-sought problem of one of the chief sources of that classic stream."

Cooley, the English geographer, has published an article in support of his belief that the great lake Nyanza, the southernmost portion of which has been described by Livingstone, and visited by several of the Portuguese explorers, is identical with the Tanganyika, the northern end of which was discovered by Burton and Speke. If this theory be true, then we shall have a great inland sea, available for navigation, eight hundred and forty nautical miles in length, and extending from latitude 2° to 12° south of the equator.

At the last meeting of the British Association, the following communication on Antarctic explorations, addressed by Captain Maury, U. S. N., to Lord Wrottesley, the President, was received and read:—

"My Dear Lord Wrottesley,—I hope the time is not far distant when circumstances will be more auspicious than at present they seem, for, as soon as there appears the least chance of success, I shall urge the sending from this country an exploring expedition to the eight millions of unknown square miles about the south pole. An expedition might be sent from Australia, with little or no risk. Two propellers, or even two vessels with auxiliary steam-power, might be sent out, so as to spend *our* three winter months in looking for a suitable point along the Antarctic continent to serve as a point of departure for overland or over-ice parties. Having found one or more such places, vessels, properly equipped for land and ice and boat expeditions, might be sent the next season, there to remain, seeking to penetrate the barrier, whether of mountain or of ice, or both, until the next season, when they might be relieved by a fresh party, or return home to compare notes, and be governed accordingly. You know the barometer, at all those places which have a rainy and a dry season, stands highest in the dry, lowest in the wet. Now I do not find any indications that the Antarctic barometer has months of high range; it is low all the year. Therefore, if I be right in ascribing the apparent tenuity of the air there to the heat that is liberated during the condensation of vapor from the heavy precipitation that is constantly taking place along the sea front of those 'barriers,' we should be correct in inferring that the difference in temperature between the Antarctic summer and winter is not very marked. If, in a case like this, we might be permitted to indulge the imagination, we might fancy the 'barrier' to be a circular range of mountains, and that beyond these lies the great Antarctic basin. Beyond this range, as beyond the Andes, we may fancy a rainless region, as in Peru, a region of clear skies and mild climates. Though the air in passing this range might be reduced below the utmost degree of Arctic cold, yet being robbed of its vapor, it would receive as sensible the latent heat thereof. Passing off to the polar slope of these mountains, this air,

then, would be dry air; descending into the valleys, and coming under the barometric pressure at the surface, it would be warm air. Leslie has explained how, by bringing the attenuated air down from the snow line, even of the tropics, and subjecting it to the barometric weight of the superincumbent mass, we may raise its temperature to inter-tropical heat by the mere pressure. In like manner this Antarctic air, though cold and rare while crossing the 'barrier,' yet receiving heat from its vapors as they are condensed, passing over into the valleys beyond, and being again subjected to normal pressure, may become warm. We have abundant illustrations of the modifying influences upon climate which winds exercise after having passed mountains and precipitated their vapor. The winds which drop the waters of the Columbia river, etc., on the western slopes of the Rocky Mountains, make a warm climate about their base on this side, so much so that we find in Nebraska the lizards and reptiles of Northern Texas. Indeed trappers tell me that the Upper Missouri is open in fall long after the Lower is frozen up, and in spring long before — several weeks — the ice in the more southern parts has broken up. The eastern slopes of Patagonia afford even a more striking illustration of climates being tempered by winds that descend from the mountains bearing with them the heat that their vapor has set free. Thus you observe that an exploring party after passing the barrier *might*, as they approach the pole, find the Antarctic climate to grow milder instead of colder. It would be rash in the present state of our information to assert that such *is* the case; but that such *may* be the case should not be ignored by the projectors and leaders of any new expedition to those regions. The existence of an open sea in the Arctic Ocean has, with a great degree of probability, been theoretically established. But the circumstances, as strong as they are, which favor the existence of an open water there, are not so strong and *direct* as are the proofs and indications of a mild *polar* climate in the Antarctic regions. I have examined the immense library of log-books here for the lines of Antarctic ice-drift. There appear to be two, both setting to the north-east, one passing by the Falkland Islands, the other having its northern terminus in the regions about the Cape of Good Hope. Further south, icebergs are found all around; but in these lines of drift they are found nearest the equator. The space between the Falkland drift and the Good Hope drift is an unfrequented part of the ocean. It may, therefore, be one broad drift, the edges of which only I have pointed out. The most active currents from the south do not run with this ice. Humboldt's current is the most active, but it does not get its icebergs as far north as they come by these lines. This circumstance has suggested the conjecture that one part of the Antarctic Continent must be peculiarly well situated for the formation of glaciers and the launching of icebergs. These lines of drift point to such a place."

An Arctic expedition, organized by public subscriptions, to follow substantially the route of Dr. Kane, and to attempt to reach the open Polar Sea, sailed during the past summer from Boston, under the command of Dr. Isaac L. Hayes (surgeon of the Kane expedition), with Dr. Sontag as astronomer. The expedition was at Upernavik August 14th, from whence Dr. Hayes writes as follows:—

"I anticipate reaching Cape Frazer, lat. 70° 42′, where I propose spending the winter. A degree lower, however, will place one within practicable reach of my proposed field of exploration. If the condition of the ice will permit, I will immediately, after a winter harbor has been selected, carry forward the boat which I intend using for next summer's labors, and some provisions, as far north as possible, and then leave them, secured against the bears, and return to the schooner after the winter has firmly set the ice. Early next spring we shall push forward advance depots, and, should we find either ice or water, we shall endeavor to accomplish with boats or sledges, or with both, the chief object of the voyage before the close of the summer. If this fortune awaits us, we shall then return home without unnecessary delay. I do not, however, anticipate this result, but I expect that we shall be detained two winters. I shall endeavor, by every means, to avoid a third year's absence. We carry with us, however, food and fuel for that period, and, in the event of our being so long detained, I do not fear adverse results. With the fresh supplies we have on board, I believe we can resist the scurvy."

The act of Congress of June 22, 1860, authorized the President to send some competent person or persons to the Isthmus of Chiriqui, to examine and report upon the quality and probable quantity of coal to be found on the lands of the Chiriqui Improvement Company, the character of the harbors of Chiriqui Lagoon and Golfito, and the practicability of building a railroad across said isthmus, so as to connect said harbors. An expedition was accordingly sent, under the command of Captain Engle, U. S. N., with Lieutenants Jeffers and Morton as engineer officers, and Dr. Evans as geologist. The reports of these gentlemen show that the harbors on both sides of the Isthmus of Chiriqui are unsurpassed; that, in the opinion of Lieutenant Morton, "it is entirely practicable to connect the harbors by a line of railroad adapted to commercial purposes;" and that the coal found there is of excellent quality, and the supply inexhaustible.

The discussion of the observations of the U. S. astronomical expedition to Chili, under Lieut. Gillis, conclusively establishes the fact that Valparaiso, and probably the whole coast of Chili, as laid down on the best charts (those of the British Admiralty), are four and four-fifths miles too far to the west, an error of much importance to navigators.

The State Geological survey of California has been organized during the past year by the appointment of Prof. J. D. Whitney as

geologist, Mr. William Ashburner filling the post of assistant geologist, and Prof. W. H. Brewer that of agricultural chemist and botanist. The act authorizing the survey also contemplates the establishment of a state museum upon a most extensive scale; and the whole enterprise is started on a most liberal and enlightened basis, and commences under more favorable auspices than any similar work hitherto projected in this country.

Dr. Newberry, the well-known geologist of Ohio, has returned to his home during the past year, after successful geological explorations in New Mexico and Utah. Some of the results of his labors are noticed in the *American Journal of Science* as follows:—

"His collection of fossils is very large, offering conclusive evidence of the geological structure of a very large area. Of the Cretaceous deposits he was fortunate in obtaining a peculiarly satisfactory analysis. Contrary to all our previous notions, these beds turn out to be much more largely developed, that is, existing in much greater force, stratigraphically, west of the Rocky Mountains than east of them. In Southern Utah (just where Marcou claims there are no Cretaceous rocks) he found beautiful exposures, of four thousand feet in thickness, of strata of that age, with abundant fossils, both animal and vegetable. The bones of a huge Saurian are among Dr. Newberry's novelties."

M. de Khanikoff has published a map of levellings, made by him in 1859, in Khorassan, Affghanistan, Seistan, and Central Persia, over an extent of two hundred thousand square miles. They are located by a triangulation connected with the triangulation of Trans-Caucasia. This vast country is subdivided into four terraces of unequal extent, and with a mean height of fifteen hundred to three thousand feet, each having a central depression and forming a basin. The first and largest contains the great desert between Koum and Nichapoor; the second and southwestern, which is the driest of all, is the desert of Loot, between Khorassan and Irak; the third, the desert of Seistan, has at its lowest point Lake Hamoon; and the fourth occupies the country between Toon Khaf and Selzar. The mountains which furrow these terraces are composed mainly of crystalline rocks, and are remarkable for their uniformity and for the extreme dryness of their slopes. The vegetation of the first and last named terraces is identical with that of the plains of Transoxiania; the others present some plants of tropical forms, similar to those of Southern Arabia. Wherever the country is sheltered against the cold northern winds, the date-tree is cultivated with success.

A geological survey of Norway is now going on, under the direction of Prof. Kjerulf, of the University of Christiana. The greater part of Southern Norway is already surveyed, and the northern part, it is expected, will be soon completed.

In 1858 the Imperial Academy of Science of St. Petersburg sent two young Russian naturalists, Messrs. Sjäwerzow and Borschtschow,

on a geological and botanical expedition to the steppes of the Kirghiz. A brief account of their explorations has just been published. The most remarkable result attained was the discovery, on the northeastern side of the Aral, of a completely marine flora, consisting of numerous species which are found in no other inland body of water, whether salt or fresh. It has been known for some time that the mollusca of the Aral, if not identical with those of the ocean, were at least very similar to them. These two facts go far to prove that the Caspian and the Aral formed originally a portion of one great oceanic bay.

General Schubert has communicated to the Academy of Sciences of St. Petersburg a determination of the figure of the earth based on the principal measurements of degrees; he believes that it is an ellipsoid with three axes, or, in other words, that not only the meridians are ellipses, but that the equator is also an ellipse, though differing very slightly from a circle.

The King of Bavaria is having executed, at his own expense, a magnetic chart of Europe, to which several years of labor have already been devoted. M. Lamont, director of these works, has addressed to the Academy of Sciences of Paris, through the intervention of M. Elie de Beaumont, curious and important details upon the determination of the constant inclinations of the magnetic needle in the South of France and of Spain. Mariners will profit by the table of the declinations of the needle in the principal ports of France, Spain, and Portugal, traced by this savant. The declination is at Toulon, 16° 45′ west; at Marseilles, 17° 7′; at Oporto, 22° 10′; at Brest, 22° 33′; at Cherbourg, 21° 38′; at Dunkerque, 20° 10′, etc. This declination has, within a century, been diminishing at an average rate of seven minutes per annum.

During the past year the Museum of Comparative Zoölogy, instituted at Cambridge, Mass., by Professor Agassiz, and for the foundation and endowment of which $225,000 was raised from the state and by private subscription, has been so far completed as to be formally dedicated and opened to the public. The plan adopted by Professor Agassiz differs essentially from that of any other museum in the world. His aim has been to make the collection help the student by the simplicity and progressive character of the arrangement, instead of perplexing him by the multitude of different objects to be studied. The student finds, first, a simple collection of the representatives of the four great types of animals, arranged as a vestibule, as it were, to the complete collection, so that the beginner who has not made his first step in zoölogy, or the visitor not conversant with the objects of the institution, can within half an hour obtain an index, as it were, of the principles of zoölogy, and learn the essential characteristics of the four great types of the animal kingdom, so as to recognize precisely what radiates, what molluscs, what articulates, and what vertebrates are. Next in order are representatives of the above classes arranged

for comparative examination and study. There is then to be a collection of animals, or fossils, arranged according to their palæontological character, that is to say, according to the geological age in which they flourished. It is also contemplated to have another collection of animals based upon their geographical distribution,—the bear of the poles being brought side by side with the reindeer, etc., of the same regions, and the lion of the equator with other animals of hot countries; and also an exhibition of embryos in all stages of their development. The museum in its present state already ranks as the ninth in the world in its special departments, and it is the hope of the founder to make it within his own lifetime equal to any.

A movement is now making to establish in Boston an institution on a most comprehensive plan, devoted to the practical sciences and arts, to be called "THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY," having the triple organization of a *Society of Arts*, a *Museum or Conservatory of Arts*, and a *School of Industrial Science and Art*. The vast and increasing magnitude of the industrial interests of New England furnishes a powerful incentive to the establishment of such an institution; and many of the leading minds of this section of country have long felt it imperative to provide for the people, in addition to the established educational systems, such facilities for acquiring practical knowledge, and for the intelligent guidance of enterprise and labor, as may make the progress of the New England States commensurate, step by step, with the advance of scientific discovery.

A recent report of the Academy of Sciences at Philadelphia gives the whole number of specimens of birds now in the museum of that society at about twenty-nine thousand. It embraces Mr. Gould's collection of the birds of Australia, also a large collection made by Captain Boys in the interior countries of India, and the collection made by General Massena, Duke of Rivoli, which was once regarded as the finest private collection of birds in Europe. Of the whole number of specimens in the museum of the society, over twenty-six thousand were the gift of a single individual,—the well-known ornithologist, Dr. T. B. Wilson.

The State Agricultural College of New York, situated at Ovid, between the Cayuga and Seneca lakes, is completed, or sufficiently so to be occupied, and will be open for instruction during the present year. Major Patrick, formerly of the army, will be at the head of the institution, assisted by an efficient corps of teachers, and the friends of the institution have great confidence that it will be largely attended by young men who intend to devote themselves to the intelligent pursuit of agriculture, and will prove a most useful and thriving school.

There has been recently established in London a Society for the Acclimatization of Animals, Birds, Fishes, Insects, and Vegetables. The Secretary is F. T. Buckland, Esq., whose name and that of his father are so thoroughly associated with natural history. The purposes

of the institution are thus set down in an advertisement: "1. The introduction, acclimatization, and domestication of all innoxious animals, birds, fishes, insects, and vegetables, whether useful or ornamental. 2. The perfection, propagation, and hybridization of races newly introduced, or already domesticated. 3. The spread of indigenous animals, etc., from parts of the kingdom where they are already known, to other localities where they are not known. 4. The procuration, whether by purchase, gift, or exchange, of animals, etc., from foreign countries. 5. The transmission of animals, etc., from England to her colonies and foreign parts, in exchange for others sent thence to the society. 6. The holding of periodical meetings, and the publication of reports and transactions for the purpose of spreading knowledge of acclimatization, and inquiry into the causes of success or failure. It will be the endeavor of the society to attempt to acclimatize and cultivate those animals, birds, etc, which will be useful and suitable to the park, the moorland, the plain, the woodland, the farm, the poultry-yard, as well as those which will increase the resources of our sea-shores, rivers, ponds, and gardens."

The Emperor Louis Napoleon, during the last ten years, has done more for the improvement of agriculture and rural economy than has been done by all the other sovereigns of Europe put together. The Emperor's farms are situated in various parts of France, from the Landes, south of Bordeaux, to the neighborhood of Paris. They are model farms, — draining, subsoiling, breeding of cattle, and other forms of agricultural improvement being carried on in the most approved manner. The French government has, since the first revolution, always bestowed special attention on agriculture, horticulture, and arboriculture. Lectures on agriculture and horticulture are delivered by first-rate men in the capital and in the provinces, and, though these are partly the results of private enterprise, they everywhere meet with countenance and encouragement from the government. Gardening is taught by precept and example in many of the elementary schools, and the young proficients are rewarded by prizes distributed by the local authorities. Among other things, the literature of rural affairs is judiciously fostered by the imperial government. The "*Ampelographie Française*" is a magnificent work on the vines of France, published under the auspices of the Minister of Agriculture. It contains a series of folio engravings of grapes in their mature state and natural sizes, carefully drawn and beautifully colored, together with an ample accompaniment of letterpress, describing the growth of the vines and the special culture of the vineyards, and exhibiting the statistics of the wine products of France with fulness, minuteness, and accuracy.

The Society of Pharmacy at Paris offer a prize of 6000 francs for the discovery of the artificial production of quinine, or, in default of this, for a substitute possessing equivalent anti-febrile properties.

The prize is open to scientists of all nations, and the time is limited to July, 1861.

In the recent revision which has taken place in the British Pharmacopœias, certain changes have been made, which, unless similar modifications be adopted in this country, will tend to embarrass the American student of British medical literature. The change consists in discarding the troy weights hitherto employed in dispensing and compounding medicines, and in adopting a new set of weights founded on the avoirdupois pound, which is divided into sixteen ounces, each containing four hundred and eighty parts, called grains, instead of four hundred and thirty-seven, as heretofore. The grain, scruple, and drachm of this new standard preserve their old relations to each other, and will accordingly be about ten per cent. less than the corresponding weights at present in use, and a proportionate addition would require to be made in the doses of the various medicines prescribed.

Mr. J. E. Wappæus has published at Leipsic, during the past year, a work entitled "General Statistics of Population," which shows conclusively that the Malthusian doctrine, that the increase of population is by geometrical progression, is a mistake. In France, for instance, the rate of increase has been steadily decreasing since the peace of 1815, it being as follows:—

1821 to 1831,	6.7 per cent.	1841 to 1851,	4.4 per cent.
1831 to 1841,	5. "	1851 to 1856,	.7 "

In England, the decrease in the rate of increase has been less:—

1811 to 1821,	16.6 per cent.	1831 to 1841,	13.5 per cent.
1821 to 1831,	14.6 "	1841 to 1851,	11.9 "

In Prussia, the annual rate of increase was:—

1817 to 1828,	1.71 per cent.	1840 to 1846,	1.27 per cent.
1829 to 1840,	1.35 "	1846 to 1856,	.69 "

In Belgium, the annual percentage of increase fell from 1.08 previous to 1846 to .42 from 1846 to 1856; in Holland, it fell from .93 previous to 1840, to .69 from 1840 to 1850.

Mr. Wappæus gives the following table of the percentage of annual increase in the countries of Western Europe, and the period required for doubling. It is based on the rate of movement during the last fifteen years:—

	Increase.	Time of Doubling.
Norway,	1.15	61 Years.
Denmark,	0.58	71 "
Sweden,	0.88	79 "
Saxony,	0.84	83 "
Holland,	0.67	103 "
Sardinia,	0.58	119 "
Prussia,	0.53	131 "
Belgium,	0.44	158 "
Great Britain and Ireland,	0.23	302 "
Austria,	0.18	385 "
France,	0.14	405 "
Hanover,	0.02	3,152 "

The aboriginal inhabitants of the Pacific islands are vanishing before the peaceful aggressions of colonization in a manner unexampled even in the history of our decaying Indian tribes. The swift decline of the Sandwich islanders is well known, but even their fearful rate of decay is exceeded by that of the more southern insular people. The Maoris of New Zealand, were estimated by Sir George Grey in 1851 at 120,000; the census of 1858 makes their number only 50,000. "Neither census," remarks one peculiarly fitted by a long residence among them to pronounce an opinion, "may be very accurate, but both indicate, what every one in New Zealand knows, that the native races are becoming extinct with a rapidity unprecedented in the annals of nations." In Tasmania the earliest European colonists found in 1803 more than 5,000 natives; they now number less than a score. In Australia the same fatal process is going on. The census of 1855 made the native population of South Australia to be 3,540, and that of 1860 shows them to have decreased to 1,700. In Victoria there were in 1848 nearly 5,000 Australian aboriginals; in 1860 there are only 1,768.

THE

ANNUAL OF SCIENTIFIC DISCOVERY.

MECHANICS AND USEFUL ARTS.

ON THE WAVE-LINE THEORY.

THE following is an abstract of a paper read before the British Institution of Naval Architects by J. Scott Russell, March, 1860, the object of which was to consider the nature of the motion imparted to water when disturbed by a vessel pushed through it by motive power of any kind:

The first inquiries to be made were, What became of all the water which a ship removed out of her way? and, How did it get out of the way? In prosecuting these inquiries, the author had first employed a small trough, or canal, a foot wide, a foot deep, and of considerable length, and began with a very simple experiment. He supported a small heap of water above the level of that in the trough by means of a partition at one end, and then withdrew the partition to see what the water would do, and found that it assumed a beautiful wave-form of its own, ran along the whole length of the channel to the end, and left the surface of the water over which it had passed as still as it was before. Had the end of the trough been just level with the surface of the still water, the wave would have jumped over, and left the whole of the water in the canal perfectly undisturbed. This phenomenon is now known as the "solitary wave of translation." This wave would travel to an almost incredible distance. The author had followed such a wave, on horseback and by other means, for miles. It leaves a little of itself, however, along the whole surface over which it passes.

The next fact ascertained was, that wherever the bow of a ship is moved through the water, a wave of this kind is produced, and this is the "travelling" or "carrier" wave, which gets rid of all the water out of the canal which the vessel has to excavate. The ship feels no more of it, for it spreads itself in a thin film all along the surface of the water, ahead of the

vessel,—not behind the vessel, nor on each side of it,—with far greater velocity than that of the vessel itself. After having made experiments on a small scale, the author took vessels on a large scale, had them dragged by horses, and in other ways, through the water, and by positive observations and measurement found that this was really what became of the water displaced by the bow of the boat. On one occasion he drew so large a number of boats along a canal in one direction, on a certain day, that the waves carried a great part of the water from one end of the canal to the other, and in the evening the water in the canal was found raised eighteen inches at one end, and depressed to the same extent at the other. The velocity with which the travelling wave moved was found to depend entirely on the depth of the water.

At	3	feet	deep the	wave	travels	6	miles	an hour
"	5	"	"	"		8	"	"
"	7	"	"	"		10	"	"
"	10	"	"	"		12	"	"
"	15	"	"	"		15	"	"
"	20	"	"	"		18	"	"
"	30	"	"	"		20	"	"
"	40	"	"	"		25	"	"
"	50	"	"	"		30	"	"

In addition to a constant velocity, this wave has a constant shape, a drawing of which was exhibited by the author. And a most extraordinary circumstance was, that its form corresponded exactly with the form of bow which he had previously, and from altogether different considerations, constructed as the form of least resistance. Moreover, he found that what he had endeavored to do in constructing that form,—viz., move the particles of water gradually out of the way, from one position of rest to another,—the travelling wave also did; for on closely observing the water in the experimental trough under the action of such a wave, he observed that it lifted every particle of water over which it passed out of one place forward into another place, and there left it perfectly at rest. In the travelling wave, therefore, as in ordinary waves, the particles of water composing it were continually being replaced by others, while the wave itself advanced without apparent change. The foregoing facts convinced the author that the form of bow which he had adopted, and which has since been called the "wave form," was analogous and conformable to the nature of water and of wave motion.

Like many others, the author at first thought that the stern of a vessel ought to be of the same form as the bow; but thought it proper to undertake a series of experiments, with the view of ascertaining what happened when a hole in the water had to be filled up. Where did the water that filled it come from? and how did it come? He first found that the hollow made in the water had no tendency to travel with an independent velocity of its own, but moved just as fast, and only as fast, as the body which produced it. He then discovered that the currents of water rushing into such a hollow, from different directions, met, and produced a wave, which he called the "following wave," or the "refilling" or "replacing wave," and which always moved with the velocity of the ship, and had nothing to do with the depth of the water. The "following wave" also repeated itself in an endless series astern of the vessel. The author explained that the nature of this wave required that the stern of the ship should be formed of cycloidal curves, and showed how this fact was applied in actual construction.

The author might be asked, reverting to the wave at the bow, What became of the water at the bow, supposing he dragged the boat faster than the water could spread itself? The answer was: With only a moderate force at his disposal the boat could not be made to travel faster; but if he had force enough to compel it to go in spite of the water, the water would rise up and stand on both sides of the boat until the load had passed, and then fall down into the hole left behind it. In a shallow canal in Scotland, where the carrier-wave travelled only seven miles an hour, he had compelled a boat to go ten miles, and he found that the water not only rose up, but lifted the boat with it, so that she drew less water than before, and actually went easier at ten miles an hour than at five. Had not railways come into fashion just at the time, the country would have been covered with little troughs, and people would have been riding on the tops of these waves in an easier and cheaper mode than by any other means then known.

After explaining the different results which are sometimes obtained at trials in the Thames, owing to the velocities of the travelling-wave varying with the depths of the water, the author described the best means of observing the wave on rivers and other like places, and then proceeded to the application of some of the principles before laid down to practice. First, he said it was a delightful circumstance that the wave-principle did not meddle at all with the form of a ship's midship section, but left the conductor entirely free to adopt any form of section he pleased. Next, it did not tie him down to any proportion of depth to breadth. It was, therefore, a plastic thing, and could be applied to any general form of ship whatever. The third and most important proposition was, that the wave-line prescribed the exact length of ship for every speed at which you wish a ship to go, and explains why a long ship is indispensable to speed. To go six miles an hour, your vessel must be at least 30 feet long; for eight miles an hour, 50 feet long; for ten miles, 70 feet; for twelve miles, 100 feet; for fifteen, 150; for eighteen, 200; for twenty, 300; for twenty-five, 400; and for thirty, 500. The author had himself tried to obtain higher velocities than these with shorter vessels; and he had got them, but at such a fearful waste of power that it was insanity and folly not to lengthen the vessels for the purpose. The wave-line theory also told you that the length of the bow should be to that of the run as 3 to 2. The cause of this was explained.

The lines of the Great Eastern, the author said, were neither more nor less than an exact copy of the wave-lines. The length of the bow was 330 feet; the length of the run, 226; and having got this length of entrance and run, and feeling that more capacity was wanted, it was of no use lengthening the bow or the run, because there was already provision for greater speed than the fifteen miles an hour which the power to be put into her could be expected to give; 120 feet of parallel body were therefore put into her amidships. The great ship might be of less fine-lines and still go with the same velocity.

There was a very valuable conclusion for practical ship-builders to be drawn, independently of what had been stated about the lines. It was this: That proportionate length and breadth were not necessary at all for a fast vessel. It was not necessary for a fast vessel that she should be a narrow, thin, long vessel in proportion to her size. The author had taken vessels on the wave-line principle two hundred feet long, and had them made of every variety of breadth, and as long as they were two hundred feet long, and had the lines belonging to fifteen or sixteen miles an hour, so long they had gone

at that velocity with a given power. Further: the resistance which a vessel experiences from the sticking of water to the skin was a most formidable element of her whole resistance; and greater velocity in proportion to power would be got out of a vessel which was shorter than another, and also broader and deeper than another, providing length enough for the velocity aimed at were got at starting.

It was the duty of the author, however, to say a word or two on the history of the subject, and the degree of novelty or non-novelty to which it pretended. And he began with saying that he did not claim to be the inventor of hollow bows. They had existed as far back as he could trace steam navigation. When he had first discovered what he believed to be the principles of nature which bore on this subject, he felt that the form of vessel which accorded with them could not be new, and he set about examining all classes of vessels. He found proofs immediately; so many, that he felt astonished that the books and treatises on naval architecture had not all told them to do nothing but make hollow bows from the beginning. He showed that it must have been impossible for barbarous men to have made a rough boat from two flat planks without forming such a bow. But the old tonnage laws had compelled builders to make ships of the greatest possible capacity compatible with certain measurements. Hence the bluff bow was made a matter of necessity. When, during the wars, we captured Spanish ships or privateers with fine and often hollow lines below, — vessels which sailed admirably under their original trim, in which they were down by the stern, — we invariably found that they proved but dull sailers in our hands, owing undoubtedly to the fact that we not only overloaded them with weights, but trimmed them nearer to an even keel, and so brought the bluff upper part of their bows down into the water. The boats of the London watermen illustrated the same principle.

The author concluded by stating that the rapid advancement of confidence in the wave principle was owing very much to the British Association for the Advancement of Science, which had placed at his disposal large means for the prosecution of scientific researches into this subject, and had every year enabled him to publish to the world the progress which he was making in the investigation.

NEW METHOD OF CLEANING THE BOTTOMS OF IRON VESSELS.

A new and novel method of cleaning the bottoms of iron vessels has been successfully put in operation by Captain R. P. Dyker, of New York City. The apparatus consists of blocks, each formed of three pieces of cork-wood and one of white-wood, firmly bolted together. On the piece of white-wood are fastened nine knives, or scrapers, six of which run parallel with the line of the vessel, and the remaining three are placed at right angles with the others. Ropes pass through these blocks, which latter may be so arranged as to be of any required length. To lengthen them it is only necessary to shackle on others. The block that comes in contact with the keel is much thicker than the others, so that it may reach that portion of the bottom which the thinner blocks would not. The blocks of course vary with the depth of keel of the vessel which is to be cleaned.

The operation of cleaning an iron brig of about two hundred tons is thus described by the New York *Commercial Advertiser:* The apparatus consisted of seven blocks, of eighteen inches in length, ten inches wide, and

seven inches in thickness; the keel block being just double this size. The blocks were cast overboard, and the rope which was attached to them was passed around the bow and underneath the bottom of the vessel, and by hauling upon the ropes alternately the scraping brought off a large quantity of dirt.

Five men were employed in the operation, which seemed quite easy. The pressure of the water kept the blocks close to the vessel's side, while the lightness of the materials added much to the rapidity with which the apparatus performed the work. As rapidly as the part of the vessel on which the apparatus was employed was cleaned, the men moved a few inches aft, until the whole bottom was thoroughly scraped. When the sharp curves of the vessel's lines interfere with the use of the blocks, a peculiar-shaped scraper, fitted to a long pole, is used, and, being floated also by cork, the work is comparatively easy and rapid.

BEACHING THE GREAT EASTERN.

The operation of cleaning the bottom of the *Great Eastern* has been performed by placing her upon a "gridiron," or framework of timber, on the beach at Milford Haven, England. The arrangement of this construction is described as follows in the *London Times:*

The beach, to the distance of five hundred and fifty feet, has been excavated and levelled to within a few feet of low-water mark at spring tides, which at high water will give a depth of twenty-five to twenty-seven feet. The beaching-place itself is composed of two "grids," fifty yards distant from each other. Each grid is one hundred and fifty feet long, constructed of forty strong transverse "baulks," or beams, of forty-five, thirty-five, thirty, and twenty-five feet long by thirteen inches square. They are laid down in four lots, ten of each length, with an interval between each beam of three feet. Each baulk of timber is firmly fixed in its place by three iron-shod piles, of from three to four feet long. The longest of these lots is laid nearest amidships, and the rest according to their length, thus tapering off to the stem and stern, so as in some degree to correspond with the beam of that part of the ship that will be immediately above them. Two "dolphins," thirty feet in height, made of four baulks, each thirteen inches square, firmly clamped and bolted together, strongly supported by back and diagonal struts, have been driven in at about three hundred feet apart.

These are for the ship's side to lie against, as well as to act as guides in the actual operation of beaching. One of these dolphins will be just forward of the starboard sponson, and the other near her starboard quarter. These, together with the mooring tackle and other necessary gear, all of which are provided, will keep the vessel in her position. The *Great Eastern* being six hundred and fifty feet long, it will thus follow that when in position she will be supported for five hundred and fifty feet of her length; viz., three hundred on the two grids, and two hundred and fifty on the levelled beach, leaving only fifty feet of her bow and stern projecting beyond the timbers and excavations. The whole structure has been made at the expense of the South Wales Railway Company, and will cost upwards of one thousand pounds.

IRON-PLATED SHIPS.

The first steel-plated frigate, constructed by the French government, was launched in September last. She is called *La Gloire*, and is a magnifi-

cent vessel, seventy-seven metres long and sixteen metres large — two hundred and fifty by fifty-one feet English. Her aspect is imposing by the severity of her lines and by the mass of her iron cuirass. At the height of 1.82 metres — barely six feet — above the water, she presents a battery of thirty-four guns of the most powerful effect; on the forecastle, two long-range pieces; on the quarter-deck, an iron redoubt to protect her commander at his post during the action. The reduced masts and wide funnel indicate that the vessel is not intended to go to a distance from our ports, but that she is made for operations in the seas where henceforward the great differences of European policy will be settled. The frigate has been thrice to sea, and it may now be said that she has gloriously terminated her trials. In calm weather she parts the water without shock, and it may almost be said without foam, showing thereby how perfectly her proportions have been conceived. Her speed, measured on a fixed basis of nearly eight kilometres, reached $13\frac{1}{10}$ knots, which is the finest result ever ascertained in a ship-of-war. In a ten hours' trip her average rate was $12\frac{31}{100}$ knots with all her fires lighted, and 11 knots with half her fires. In a rough sea she behaved perfectly. She pitches very gently, and rolls with a regularity that leaves nothing to be desired. — *Moniteur de la Flotte.*

THE FASTEST STEAMBOAT-RUNNING ON RECORD.

On the 13th of October, the steamboat *Daniel Drew* made the trip between New York and Albany in six hours and fifty minutes, with five landings and against a head wind. The distance on the Hudson River route between the two places is considered to be one hundred and fifty miles; and if we allow ten minutes for each of the landings, — they having to be made on both sides of the river, — the actual running time will be six hours, and the average speed twenty-five miles per hour. This is equal to locomotive running, and the fastest ocean steamers, in the calmest weather, do not come within eight miles per hour of this figure. — *Scientific American.*

IRON SHIPS.

A congress of the most eminent ship-builders and naval architects of Great Britain assembled in London, in April, 1860, — Sir John Packington in the chair, — for the purpose of discussing different points of interest in their profession.

One of the most important topics brought forward was the construction of iron ships, and the following is an abstract of the discussion which took place on the subject. Mr. William Fairbairn stated that he had been engaged for a period of forty years in various works connected with iron, and its application for ship-building purposes. About thirty years ago, in conjunction with the Messrs. Laird, of Birkenhead, he found by numerous experiments that vessels made of iron would be capable of more resistance, lighter, and better calculated for a large cargo, than timber-built vessels. Messrs. Laird and himself then commenced building iron vessels on a large scale, and from 1835 until 1848 upwards of one hundred first-class ships were produced. When first constructed, iron vessels had many defects; great improvements had since taken place, but much remained to be done. Of late years this class of vessels had been constructed very long, in order to give them fine lines and increase their carrying power; but hitherto this increase of length had been obtained at an expense of the strength of the

ship. In many cases the length of iron vessels was eight or nine times that of the beam, and although he did not say that such had yet obtained their maximum length, yet the mode of construction was capable of much improvement. He assured them that vessels in a rolling sea, or stranded on a lee-shore, were governed by the same laws of transverse strain as hollow iron beams, like the Britannia tubular bridge; hence a ship could not be lengthened with impunity without adding to its depth or the sectional area of the plates in the middle. An iron ship of the ordinary construction — 300 feet long, 41½ feet beam, and 26½ feet deep — was inadequately designed to resist strains when treated as a simple beam; and a ship was like a simple beam when supported at each end by waves, or when, rising on the crest of a wave, it was supported on the centre with the stem and stern partially suspended. In these positions an iron ship underwent, alternately, a strain of compression and a strain of tension along the whole section of the deck, corresponding with equal strains along the keel. Such a vessel could make a number of voyages at sea, because it was there sustained in a measure by the water; but when driven upon a rock, with its bow and stern suspended, it would break in two, owing to the insufficient mode of constructing the decks. An iron ship of the foregoing dimensions, as usually constructed and tried by the beam formulæ $W = (a\ d\ c \div l)$, would be broken asunder if tried with a weight of nine hundred and sixty tons suspended from bow and stern. But if the deck-beams were covered with iron plates throughout the whole length on each side of the hatchway, so as to render the deck area equal to that of the bottom, we should have nearly twice the strength. He next considered the displacement of such a vessel in tons, and found the strength far from satisfactory. When loaded to a depth of eighteen feet, the displacement was about one hundred and seventy-seven thousand cubic feet — equivalent to five thousand tons for the ship and cargo. If we considered this weight uniformly distributed, and compared it with the strength determined, we have a load uniformly distributed of five thousand tons added to that of the breaking weight of the metal in the vessel, which would leave a deficiency of strength equal to one thousand one hundred and sixty tons; so that, if laid high and dry on a rock at the centre, it would break with four-fifths of the load which it carried. These were extreme cases, but ships should be built for them if possible. There had been improvements introduced recently in iron vessels, still they were all too weak in the decks. These, he argued, should be so strengthened as to be equal to the keel, and thus provide a margin of strength for every contingency. He recommended the addition of two longitudinal stringers, running one on each side of the keel; the covering of the cross-bearers of the upper deck with iron stringer plates, thickest towards the middle; also two cellular rectangular stringers — one on each side of the hatchway — all running the whole length of the ship. He also argued the importance of using the best quality of metal. No plates should be employed that were incapable of withstanding a tensile strain of twenty tons per square inch.

Mr. J. Scott Russell pointed out various improvements which he had carried out, especially with relation to water-tight bulkheads. These were a source of great strength to iron vessels, as they were placed inside the ship; and even if a collision took place, and the ship was cut through, they would save it from sinking. Twelve years ago he built a vessel which might be described as all bulkheads, and entirely divested of frames. Believing that the centre of the vessel required to be essentially strong, he

carried a web of iron completely through it, in some cases passing through the bulwarks, and sometimes avoiding them.

Mr. Ritchie (surveyor of Lloyd's Register) said he should like to hear something from Mr. Russell on the subject of rivets.

Mr. Russell said that was a most important matter in the construction of iron ships. He had recently inspected a vessel returned from a voyage, and found that the heads of at least one thousand rivets were off. How they came off was a mystery to him; but he gave a very modest rap with a hammer, and one of the rivets dropped out. He had adopted the system of conical riveting, which he found to answer very well, as, when the head was gone, the rivet was perfectly water-tight.

Mr. Napier (of Glasgow) observed that he did not approve of the tubular system advocated by Mr. Fairbairn; and it must be remembered that a stationary tubular iron bridge had not to contend with the constant strain of the sea. Many and conflicting opinions prevailed as to the best form of the keel; some were for having it flat, others sharp — and perhaps both were right. (Laughter.) For his own part, he did not build a vessel to go on the rocks; but if she were taken there he could not help it. If they could possibly arrive at the absolute breaking power of the sea which an iron vessel would bear, it would be a great discovery. He agreed with Mr. Scott Russell, that it was not in the power of man to build a ship which would be able to bear up against the breaking power which the *Royal Charter* encountered as the sea went over her broadside.

Mr. Fairbairn again addressed the meeting, expressing his opinion that iron ship-building was at present in a transition state. They required to have better and stronger plates; and if owners would only give a fair price for their vessels, many catastrophes which resulted from the use of bad iron might be averted.

ON THE EFFECTS OF VIBRATORY ACTION AND LONG-CONTINUED CHANGES OF LOAD UPON WROUGHT-IRON GIRDERS.

In a paper presented by Mr. Fairbairn to the British Association for 1860, the author detailed the results of a set of experiments, having for their object the determining of matters with which the public are intimately concerned, viz., the efficacy of girders supporting bridges over which railway trains are constantly passing. It is well known that iron, whether in the shape of railway axles or girders, after undergoing for a length of time a continued vibratory or hammering action, assumes a different molecular structure, and, though perfectly efficient in the first instance, becomes brittle, and no longer capable of sustaining the loads to which it may be subjected. Mr. Fairbairn stated that the practical conclusion to which his experiments, so far as they had at present gone, would lead, was, that a railway girder bridge would, irrespective of other causes, last a hundred and fifty years.

IMPROVEMENT IN THE STEAM-ENGINE.

An improvement in the construction of steam-engines recently devised and patented by Richard Barton, of Troy, N. Y., has for its object, first, to enable a steam-engine having a long cylinder, and consequently a long stroke of piston, to be brought within a comparatively small space; and, second, to enable two complete revolutions of the crank shaft to be pro-

duced by the stroke of the piston back and forth. The invention consists in connecting the piston-rod and crank of an engine by means of a system of toggles and connecting-rods, applied and arranged in a peculiar manner, whereby the above objects are accomplished, and an engine possessing superior qualities for driving the screw-propeller is obtained.

ERICSSON'S CALORIC ENGINE.

The applicability of Ericsson's caloric engines for all but a very few of the thousand uses for which power is required, has within the past few years been sufficiently demonstrated, and the introduction and use of them is no longer a matter of experiment. More than five hundred of these engines — varying in dimensions of cylinder from 6 to 32 inches — are now in successful operation in different parts of the country. Many of these are employed as domestic motors in pumping water. A large number, chiefly 18-inch cylinders, are performing a similar office at railway stations. Mr. Vibbard, the General Superintendent of the New York Central Railroad, after having had five of these engines in use at water-stations for several months, reports officially, over his signature as superintendent, that they perform an "incredible" amount of labor "for the small quantity of fuel consumed." One of them, at the Jordan station, he says, performs the labor of four men, at an expense of $\frac{96}{100}$ of one cent per hour; and one at the Savana station does the labor of five men, at a cost of eleven cents per day, making a saving of over $120 per month. "We have decided," he says, "to use the engines at all stations where we are compelled to supply locomotives by pumping." An engine of the same size at the Newmarket station, on the New Jersey Central Railroad, raises thirty-three thousand gallons of water at the cost of less than nine cents a day, or fifty-three cents for six days, as appears from the certificate of Mr. Overton, road-master.

For driving printing-presses, the caloric engine has been found equally useful. Fifteen daily newspapers in the United States are now printed by it, and we need not add that a daily paper calls for a motor that is economical, efficient, and in all respects reliable. The engines thus employed are of 18-inch and 24-inch cylinders.

Engines of 24-inch and 32-inch cylinders are used in raising grain at railway stations, and merchandise in large stores; in pulverizing quartz, splitting leather, propelling sewing-machines, pulping and hulling coffee, ginning cotton, and crushing sugar-cane.

The 24-inch engine has also been successfully applied for ships' uses, in pumping, loading, and discharging cargoes, warping ship, handling the anchor, and for many other purposes now calling for manual labor.

Many engines have been sent to Cuba, where they have been successfully applied to various uses. And within a recent period an order has been issued by the governor forbidding the erection of any other kind of engines in the city of Havana, or in any town on the island.

It is found that, with every increase of dimension, the power of the engine is more than proportionately increased; and while the engine has been from time to time enlarged from 6 to 8, 12, 18, 24, and 32-inch cylinder with complete practical success, there is no reason to believe that the 48 or 60-inch cylinder will express the limit of available and economical power. It is sufficient to say that this limit is not yet ascertained, and that actual results indicate that it has not been approximated.

Several of the largest machine-shops in the United States are now engaged in the manufacture of these engines, under licenses from the patentee. Among these we may mention the establishments of I. P. Morris & Co., of Philadelphia; the Newark Machine Co., of Newark, N. J.; Clute Brothers, of Schenectady, and William Kidd & Co., of Rochester, New York; and Nourse & Caryl, of Boston. Mr. John B. Kitching has established a general agency for the engine in New York City, where he sells machines of his own manufacture, and those of the manufacture of other licensees.

It is but an act of justice to the caloric engine to state that the claims that are made for it of entire safety and great economy seem to be abundantly sustained by competent testimony; and we do not forget that the only competent testimony in the case is that of men who have themselves employed the engines, or watched them diligently and intelligently in the actual performance of their offices. Such testimony is that of Professor Henry, officially made to the Lighthouse Board, to the practical operation of an 18-inch caloric engine in its application to Daboll's fog whistle, or trumpet. He says: "It [the caloric engine] is very simple in construction, easily put in operation; . . . easily worked, and not liable to get out of order. . . The quantity of fuel required to supply the necessary amount of motive power is too small to be considered an item of importance. The furnace holds about a peck of coal, and no addition to the fire was made during the time the committee was making the examination, though the engine was constantly in motion for several hours. But the properties which more particularly recommend it for the purpose of signals are, that it offers not the least danger of explosion, and no water is required for its operation."

LENOIR'S GAS-ENGINE.

Considerable interest has been excited during the past year, in Paris, by the exhibition of a working gas-engine, devised by M. Lenoir, a French engineer.

The machine in question somewhat resembles an ordinary steam-engine, but its motive power is obtained by the combustion of the ordinary illuminating gas, mixed with atmospheric air. In certain proportions, this mixture is explosive, as gas-engineers well know. But in Lenoir's machine the detonating proportion of two volumes of gas to one of air is avoided, and the highest combination allowed is one of gas to nine of air. Besides, the two are not brought into contact till they have entered the cylinder, when they are ignited by a spark from a little Ruhmkorff apparatus, and the dilatation of the gases forces the piston forward with great force. When the piston reaches the end of the cylinder, it is carried back a little way by the momentum of the fly-wheel, opening a valve at the same time, and admitting another supply of hydrogen and air, which is ignited by an electric spark, and so the alternate motion is established. The whole machine is simple and beautiful, and the only question as to its utility seems to be the very important one of economy.

On this point M. Lenoir states, (1), that the prime cost of his machine is only about half that of a steam-engine of the same power; and, (2), that even in using street gas, at the rate of $1.60 per thousand feet, the saving of fuel, as compared with the steam-engine, is at least fifty per cent., and that they hope to obtain the non-illuminating gas, which will answer the purpose just as well, at one-sixth of the price mentioned. One disadvantage of the

steam-engine is shared by M. Lenoir's, viz., all the heat generated cannot be converted into power. If there was nothing to hinder the complete expansion of the gases, the temperature of the expanded gas would be as low as before the combustion; but, after a certain point of dilatation is reached, the expansive force left is not sufficient to move the piston, and the air must then be turned into the waste-pipe, though still very highly heated. On the other hand, there are several advantages claimed. Besides the low prime cost and alleged economy of fuel, there is a great saving from the facility of starting the machine in an instant — certainly a very great advantage, considering the loss of time and fuel attendant upon raising steam. Then there is considerable expense involved in stopping a steam-engine, which is obviated here; the combustion in Lenoir's engine being stopped instantaneously by the turning of a button.

ON A METHOD OF TESTING THE STRENGTH OF STEAM BOILERS.— BY DR. JOULE.

The author adverted to the means hitherto adopted for testing boilers. First, That by steam pressure, which gives no certain indication whether strain has not taken place under its influence, so that a boiler so tested may subsequently explode when worked at the same or even a somewhat less degree of pressure. He trusted that this highly reprehensible practice had been wholly abandoned. Second, That by hydraulic pressure obtained by a force-pump, which does not afford an absolutely reliable proof that the boiler has passed the ordeal without injury, and, moreover, requires a special apparatus. The plan which had been adopted by the author for two years past, with perfect success, was free from the objections which applied to the above, and is as follows: The boiler is entirely filled with water, then a brisk fire is made in or under it. When the water has thereby been warmed a little, say to 70° or 90° Fahrenheit, the safety-valve is loaded to the pressure up to which the boiler is to be tested. Bourdon's or other pressure indicator is then constantly observed; and if the pressure occasioned by the expansion of the water increases continuously up to the testing pressure, without sudden stoppage or diminution, it may be safely inferred that the boiler has stood it without strain or incipient rupture.

In the trials made by the author, the pressure rose from zero to sixty-two pounds on the square inch in five minutes. The facility of proving a boiler by this method was so great, that he trusted that owners would be induced to make those periodical tests, without which fatal experience had shown that no boiler should be trusted. — *Newton's (London) Journal.*

THE GAUGE OF RAILWAYS.

The London *Engineer* says that experience has demonstrated a narrow gauge to be decidedly superior to a broad gauge for railways. The power required to work them is much less, broad gauge roads requiring engines and carriages of excessive weight. The broad gauge necessitates longer axles, which increase the liability of one wheel to run ahead of the other on the same axle, to which there is a tendency on all roads, and a consequent binding of the wheels between the rails. It is perfectly established that the narrow gauge affords sufficient space for the heaviest engines.

THE CONTINUOUS RAIL.

Our readers are aware that a continuous or compound rail has been for some years employed on various railways; that it has made an obviously improved, smooth, and easy-riding track, when new, at least, and that it is still largely used on the New York Central and other lines. But the general impression is, that it has not proved remarkably successful, if, indeed, it has not decidedly failed. A very brief review of the history of continuous rails, however, and of the circumstances of American roads, will show that the plan is a decided improvement in every particular; that its first cost, and renewals, and the repairs of the rolling stock carried by it, are much less than in the case of the common rail.

The first continuous rail was the common rail split vertically from top to bottom — the two nearly equal parts breaking joints with each other, and fastened together with rivets. In case of wheels worn on other and different sized rails, the whole bearing might come on one of these parts, rapidly crushing it, and prying the two apart. The lamination of the inside edges still further sundered the two bars, and the frost rapidly split them apart, breaking the rivets. This rail was impracticable, although for a few months it made the best road ever laid. While it was good, and before it had seriously deteriorated, it was believed to have saved enough repair expenses of way and machinery to have nearly paid for its extra cost. The next plan of continuous rail had a split head and a solid foot, half the section of the head resting on the foot of the other half. The abrasion of the iron upon iron, in the absence of rigid connection between them, soon destroyed this rail, but it manifestly decreased the repair expenses of machinery. A successful continuous rail was then brought out, which had a split foot and a solid head, the small section of the foot forming a sort of continuous splice, or bracket-joint. This has been in service for above six years on the New York Central. It is to be regretted that that company has not kept a more definite record of the influence of the continuous rail on the repair expenses. The obvious results of long practice, however, are such that it is still largely used, and that the manner in which it eases the shocks usual at the joints of common rails, and its uniform elasticity, have made it a decidedly paying investment. But the philosophy of permanent way, as deduced from the general experience, is more conclusive. No one will dispute the fact that the thorough ballasting and drainage of the road-bed will allow the use of such a high rail as can alone be thoroughly spliced at the joints. But this high rail is necessarily rigid, and if not supported by an even bed of ballast and sleepers, will bring its bearing on widely distant parts of the road-bed, since it cannot yield so as to bear on all parts; hence the rail will permanently bend and rapidly deteriorate, and, when both rigid and rough, will form the worst imaginable track. The experience with the seven-inch rails on the body-ballasted part of the Camden and Amboy line proves this, while much heavier rails on the English well-ballasted lines outlast light rails on the same road-bed. A light, yielding rail, however, on a mud road-bed, will adapt itself to the churning of the sleepers, and take a bearing on the whole of the bed. It will not permanently set when sprung and twisted, and if it becomes bent on a very bad line, it will not be both rigid and rough, but will be somewhat elastic under the wheels. It appears, then, that we must have either tolerable ballasting and drainage, — a good road-bed, — or else a shallow and yielding rail. Since our managers are either too limited as to

means, or too unwise when they have the means, to institute the fundamental remedy, the compromise is generally a low rail, which, for the very reason of its shallowness, cannot be spliced at its signally vulnerable point, the joint. So the difficulty engendered by a low rail is almost as serious as that sought to be avoided by the low rail — the disconnected joints soon wear and hammer themselves and the machinery to pieces. Now, several hundred rail-joints have been invented, some of which really preserve, to a considerable extent, the continuity of the rails as if they were a continuous bar; but those that do so run into two obstacles, which are nearly fatal: 1. The cost of thoroughly jointing a low rail is too enormous, in the eyes of those who will use low rails, at all to warrant its adoption. 2. The necessary weight and rigidity of a good joint are so great as to destroy the very effect sought in the low rail—continuous elasticity. Now, the continuous rail is the compromise between these almost irreconcilable elements. It is a continuous splice, not, indeed, preserving the full strength of the bar at the joint, but preventing much deflection, and equalizing what there is; that is, bringing down both rail ends alike. This it does without adding rigidity, for the weight is the same at all parts. The cost of the continuous rail is five dollars a ton over that of the solid rail of equal weight. This makes the joints cost about a dollar each; and we know of no other joint, costing a dollar, which so securely fastens the ends of low rails, — for the lower the rail the greater the difficulty in jointing it. — *New York Times.*

DO RAILWAY RAILS EVER WEAR OUT?

Mr. Herapath, editor of Herapath's *Railway Journal* (England), states, on the authority of some of the most practical and experienced railway men of Great Britain, that railway rails, unless at stations and places where there is sliding, do not sensibly wear out. This statement, however, applies to rails made of good iron, — not inferior iron tinned over, as it were, with good, — and to rails on the middle of a line, over which trains are run in the ordinary way. Experiments have been made by taking up and carefully weighing rails in this position after twelve months, wear, or more, which were found not sensibly to have lost any weight during that time, thereby proving that there could have been no sensible wear.

THE BISSEL LOCOMOTIVE TRUCK.

The common locomotive truck consists of a frame, holding the four front wheels, and turning on a pivot, or king-bolt, like the fore axletree of a wagon. Although such a truck moves round a curve more easily than if it were rigidly parallel to other shafts and did not turn on its king-bolt, yet its action is hard, like that of a car whose wheels are nearer together on one side than on the other when moving on a straight track. With the Bissel improvement, the truck does not turn on its own centre, or pivot, but slides sidewise under the engines, being held by a radius-arm extending back under the engine, and fastened to a pin half-way between the centre of the truck and the forward driving-shaft. Thus all the axles of the engine are more nearly radial to whatever curve the train strikes; the wheels are less likely to run off, and move with less friction; shorter curves may be passed, and the flanges wear less. The chief improvement is, however, that one pair of wheels may be used instead of two pairs, which are necessary in the old

truck. Another incidental and considerable advantage is, that with a single shaft the bearing of the engine is thrown further forward, and the weight necessary to adhesion is thrown further back upon the driving-wheels.

IMPROVED LOCOMOTIVES.

The introduction of cheap steel, and the gradually spreading fact that combined strength and lightness at any reasonable cost will pay at once and handsomely as features of locomotive machinery, are leading to a signal improvement in the locomotive engine. At the Albany Iron Works, semi-steel is being largely introduced for all parts of boilers, allowing twenty-five per cent. increase of strength with the same weight, or twenty-five per cent. decrease of weight with the same strength. It is probable that a higher pressure will be employed, since it is economical in itself, and that boilers will be somewhat lightened. Steel tires of the same make are now undergoing a so far promising trial. They will greatly add to the durability of engines, and decrease weight where lightness is most needed — in the parts unrelieved by springs, which act as a forge-hammer directly on the rail. The above features cost no more in semi-steel than in iron, and therefore should come into much more rapid use. Krupp's Prussian steel axles — the best in the world — are finding favor at double the cost of iron. We do not hear that they ever wear out or break. They have not been in use long enough to show old age yet, though some have run in this country over a dozen years. Another decided improvement in locomotives is in the proportions of the boiler and the steam-generating apparatus. Smaller grates, larger combustion room, a very much larger water-circulating space, — allowing less nominal and more real heating surface, — and the modern apparatus in the smoke-box for facilitating draft, have considerably decreased the consumption of fuel and the wear of boiler in the production of a given power.

THE MANUFACTURE AND DEFECTS OF CAST-IRON CAR-WHEELS — AN IMPROVED WHEEL.

The supply of car-wheels to railway equipment has become a distinct and extensive branch of the foundry business. Several very large establishments, and many smaller ones, are constantly employed in this single manufacture. Wrought-iron wheels, such as are almost exclusively used in Europe, are too expensive, according to our railway policy — a reduction in first cost is the leading consideration; while the flanges of wrought wheels rapidly cut out on our most crooked roads, rendering a harder material desirable. Steel tires, which are, scientifically considered, the best known for durability and shape, — roundness, — are very much more expensive; and our roads have not yet found it expedient to introduce them. The improvement we shall describe will furnish many of their advantages at a very cheap rate.

The service of car-wheels, especially on our rough roads, is very severe; great strength to resist side and other strains, and the incessant hammering of our jointless rails, and extreme hardness of the tread or rolling surface to prevent rapid wear, together with the greatest possible lightness, are essential. To embody these conditions in a single casting is more difficult than the uninitiated would imagine; the nature of the metal itself is in most respects adverse to such a result, though in one respect it is extremely favor-

able. There are certain kinds of strong, hard iron, which, when melted and suddenly brought in contact with a cold metallic surface, will "chill;" a stratum of the iron about half an inch thick will be converted into white, fine-grained surface, of such extreme hardness that ordinary files and drills will make no mark on it. Such iron is poured into moulds, of which the part touching the tread of the wheel is a ring of metal, which chills the surface, — the rest of the wheel cools more gradually, and is only a little hardened, — for "chilling iron" always hardens when recast — so much so, that new admixtures of pig-iron must be added, or it will become too brittle and "short" for wheels. But the wheel, while cooling, contracts unequally, since the thickness of its parts are different, leaving a severe and permanent strain — an inherent tendency to fly to pieces, which the roughing of our roads does not ameliorate. To make a shape, by means of corrugations of innumerable forms and directions, that will allow the parts to yield to this contracting force while cooling, so that no strain shall be left in the wheel, has been the subject of hundreds of patents. Again, the "chilling iron" that must be used for the tread is too hard and brittle to answer the best purpose for the rest of the wheel, while the softer and tougher irons that are best to resist strains will not chill; so a single casting cannot fulfil every desirable condition.

It has long been the custom of some lines to use chilled cast-iron tires on locomotive driving-wheels. They are much harder than wrought tires, and wear better; they are not so truly round as wrought iron or steel tires, which are turned in a lathe; their adhesion is less, and they are very heavy and hard on the track. Yet they are very much cheaper than wrought iron, not to speak of steel. Considering their immense weight, their economy in the long run is questionable. But this chief objection has been partially obviated by Mr. H. W. Moore, of the Union Car-Wheel Works, Jersey City, who has perfected a process of casting the tire hollow, thus reducing the weight of a four and a half feet tire from one thousand pounds to seven hundred and twenty pounds, and at the same time preserving its strength, if not increasing its soundness.

All these facts bring us to the consideration of Mr. Moore's improved car-wheel, which is simply a nave or centre-piece of tough, strong cast iron, and a hollow tire of hard chilling iron. The two, when fastened together by the very simple process used in fastening the same kind of tire to driving-wheels, form a complete cast-iron wheel, which possesses the following very obvious and very important advantages: First, The nave, or centre-plate, never wears out, it being practically a part of the axle. When a common wheel is worn out, the whole of it is used up, and, being all of "chilling iron," cannot be recast into wheels without a large admixture of pig-iron. With the new wheel, the tire only is removed when it wears out. Second, The nave, being subject to no wear whatever, may outlast the axle, and be fitted to new axles as the latter wear out. Third, The nave may be made of softer iron than the tread or tire requires, and so be less liable to breakage. Fourth, The tire may be of harder iron than is required for the nave, and so chill deeper and harder, and wear longer. Fifth, The wheel as a whole is stronger, no strain being left in it by the unequal contraction of the metal as it cools. As before mentioned, the great trouble has been that the quickly cooling tire and the thicker and slower cooling hub cause a severe and permanent rupturing force to be left in the wheel when it is a single casting. In this case, the thin, hollow tire cools without strain, and the nave may be

easily proportioned so as to cool without strain; besides, the tire is a hoop and binder in this case, rather than a rupturing force. Sixth, The expense and time required to put on a new tire are less than half what are required to put on a new wheel. The latter process involves taking out the axle, putting it into a press, forcing off the wheel, forcing on a new one by screw or hydraulic power, and replacing the wheel. Putting on a new tire where the wheel is outside of the journal, as on locomotives and some tenders and cars, does not necessitate taking out the axle at all; the engine or car is simply jacked up, a few nuts are unscrewed, the old tire is slipped off, and a new one slipped on. Seventh, If the tire breaks, the car has still a wheel to run on, the broad periphery of the centre-plate or nave being left, which is less likely to cause running off the track than a broken solid wheel. Eighth, Not only is the wheel vastly better in every respect than a solid wheel, but the expense of this generally most expensive department of repairs is greatly reduced. The price of a common wheel being thirteen dollars and fifty cents, the price of the double wheel is sixteen dollars, of which the tire, turned out and furnished with four bolts, costs nine dollars. Two common wheels cost twenty-seven dollars, while the first double wheel and a new tire for the old centre of the double wheel cost twenty-five dollars, saving two dollars on the two sets of wheels. Supposing the old nave to outlast three tires, six dollars and fifty cents are saved; and supposing it to outlast six tires, — which is a reasonable supposition, — twenty dollars are saved; that is, compared with the cost of six common wheels, the new wheel will have cost nothing, and will have saved six dollars and fifty cents besides. When these figures are applied to the thousands of car-wheels renewed yearly on our great lines, not to speak of the grand aggregate on all the railways in the country, the saving promised by this improvement is to be represented by millions of dollars. — *N. Y. Times.*

ON THE ACTION OF HEAT-DIFFUSERS.

The following paper has been communicated to the British Association by Mr. Arthur Taylor:

Mr. Williams and others have found that an increased effect was produced by the fuel burnt in steam-boilers when what have been called Heat-Diffusers were placed in the tubes or flues. The apparatus in question consists generally of metallic bands or ribands, twisted into spirals, or bent in the direction of their length into zigzag forms, and placed in the tubes or flues, the professed object of this addition being to break up or disturb the current of heated gases passing through the tubes, and to cause every portion of the gases to impinge on the heating surfaces, — the cause given for the increased effect produced being, that when a current of heated gases passes through a tube under ordinary circumstances, only the exterior portions of the columns come in contact with the sides of the tube, and that in thus disturbing the current by obstacles to its direct course a more perfect contact of the gases with the surfaces is produced. The question which I wish to raise is, whether this is the true explanation of the effect produced by diffusers, deflecting bridges, etc. I think it can hardly be admitted that each molecule of a gas passing through a tube follows a course parallel with the axis; for those in contact with the sides of the tube will be so impeded by friction as to have a much slower motion than those in the centre; just as in a river the current near the banks is less rapid than that in the middle of the

stream; and that as in the river, so in the tube, a series of eddies will be formed, tending to bring all portions of the gas in contact with the sides of the tube. This peculiar motion of gases in a tube may very clearly be observed in the smoke issuing from the funnel of a steamer, the smoke retaining the eddying motion which it had in the funnel for some time after leaving it.

These considerations led me to consider the mere disturbance of the currents as inadequate to explain the increased evaporation observed, and to attribute it to a very different cause. Gases do not radiate the heat which they contain; so that the only mode in which a gas can communicate its heat to a surface is by contact or convection. This is, in the present practice, the only mode in which those heating surfaces of a boiler which are not exposed to the radiation of the fire, or flame, can abstract heat from the products of combustion; but if in a flue or tube a solid body be introduced, it will become heated by contact with the gases, and will radiate the heat thus received to the sides of the flue. Now these diffusers, etc., exactly fulfil these conditions; and I, therefore, attribute their effect mainly, if not entirely, to the function which they must fulfil in absorbing heat from the gases by contact, and then radiating this heat to the sides of the tubes or flues. And I think it will be admitted, that the amount of heat thus conveyed to the water may be very important, when it is considered that the temperature of the gases in the tubes of a boiler, at five or six inches from the fire-box tube-plates, is about eight hundred degrees Fahrenheit; and that these radiators will consequently have a temperature of several hundred degrees above that of the surfaces in contact with the water in the boiler, and that a very active radiation must consequently take place from one to the other. This principle once established, the modes of application in practice are, of course, endless; and I will only mention that I do not see any advantage in making these radiating surfaces of such a form as to impede the draught,—especially in the case of marine boilers,—but would rather choose the form which would give the greatest amount of radiating surface, and offer the least impediment to the free passage of the products of combustion through the tubes. Perhaps as effective a form as any for placing in the tubes of boilers would be a simple straight band of metal, or a wider band bent in the direction of its breadth at an angle of sixty degrees. In the case of marine boilers, they should be made so as to draw out easily, to enable the tubes to be swept.

ON THE COMBUSTION OF WET FUEL.

The following is an abstract of a paper read before the American Association, 1860, by Professor B. Silliman, Jr., "On the Combustion of Wet Fuel in the Furnace devised by Moses Thompson." In all ordinary modes of combustion, it is well known that the use of wet fuel is attended with a very great loss of heat, rendered latent in the conversion of water into steam. As the most perfectly air-dried wood still contains about twenty-five per cent. of water, the term *wet fuel* might seem appropriate to all fuels but mineral coal and charcoal. But, technically, this term is restricted to substances like peat, and those residual products of the arts, which, like wet tan, begasse, and spent dye-stuffs, contain at least one-half, and often more than half, their weight of water. Until a recent period, the attempt to consume these products as sources of heat has been attended with uneconomical results,

or total failure. It is the object of this paper to describe a mode of combustion, in which, by a modification in the form of furnace, the combustion of wet fuel is not only rendered consistent with the best economical results, but which involves chemical reäctions never before, it is believed, successfully applied for such purposes, and which is deserving of particular notice from a scientific as well as from a practical point of view.

It is a well-established fact in chemistry, that the affinity of carbon for oxygen at high temperatures is so strong, that if oxygen is not present in a free state, any compound containing oxygen, which happens to be present, is decomposed, in order to satisfy this affinity. This fact is well illustrated in the familiar case of the blast-furnace, where this affinity is employed to deprive the ores of iron of their oxygen in the process of reduction to metallic iron.

In the first stages of combustion, in wet fuels, the chief products given off are steam from the drying of the wet mass, smoke, or volatilized carbon, and oxide of carbon, with, of course, a variable proportion of carbonic acid and carburetted hydrogen. These products, in all ordinary furnaces, pass on together into the stack, carrying with them the heat which they have absorbed and rendered latent. The problem presented is then to recover the heat thus locked up and lost; and by the furnace now under consideration this is accomplished by shutting off almost entirely the access of the outer air, and causing the wet fuel to supply its own supporter of combustion, drawn from the decomposition of the vapor of water at a high temperature, by its reäction with free carbon and the oxide of carbon.

The practical solution of this problem was first successfully accomplished, as appears from a decision of Patent Commissioner Holt, by the late Moses Thompson, in 1854. The controversial questions growing out of this invention are entirely foreign to our present purpose, and in no way affect its practical or scientific value. Suffice it to say, in passing, that we find in this invention another instance of a truth already so often signalized in the history of inventions, that important results are often obtained, of the highest value in promoting material prosperity and the welfare of society, by those who are guided in their search only by the result in view, and not by any exact knowledge of the scientific principles involved.

Mr. Thompson seems to have been inspired with the conviction that if he could bring the products from the combustion of wet fuel together in a place hot enough for the purpose, and from which the atmospheric air was excluded, they would, as he expresses it in his patent, mutually "consume each other." This notion was realized, and the reäction secured between the elements of water and the carbon of smoke, or the oxide of carbon, in a part of the furnace called by the inventor the mixing-chamber.

Wherever that place may be situated, or however constructed, the one essential thing about it is, that it should be a very hot place, and one to which the atmospheric air can have no direct access until it has passed by and through the burning fuel. It is, in fact, a retort, or place for combination and reäction, and may be a distinct chamber or flue, or only a recess or enlargement, greater or less, of the main furnace. Wherever it may be placed, or however built, it must meet the essential conditions of a high temperature, and of atmospheric isolation. In this mixing chamber, then, the important chemical reäction before insisted on must be set up. The vapor of water is decomposed, furnishing its oxygen to the highly heated carbon to form carbonic acid, while the oxide of carbon is in like manner

exalted to the same condition, and any excess of carbon forms, with free hydrogen, marsh gas, or light carburetted hydrogen. The vapor of water is thus made to give up not only its constituent elements to form new compounds with oxygen, producing in the change great heat, but a great part of the heat absorbed by the water in becoming steam is also liberated in this change of its physical and chemical condition. Moreover, as all these products of combustion and of chemical reäction pass together over the bridge-wall of the furnace into a space from which atmospheric air is not excluded, it then and there happens that any free hydrogen, light carburetted hydrogen, or oxide of carbon which have previously escaped combustion, take fire and burn, yielding up their quota of heat to the general aggregate.

Such is the intensity of heat in that portion of the furnace where these reäctions take place, that only the most solid structures of refractory fire-bricks will endure it, and the color seen throughout that portion of the furnace is of the purest white.

In view of the facts already stated, it is easy to understand why it is that when the reäctions described are once set up, the admission of a free current of atmospheric air should immediately check the energy of the combustion, and soon result in total suspension of the peculiar energy of this furnace. The air containing only one-fifth of its bulk of oxygen gas, the active agent in combustion, the access of so large a proportion of cold air, four-fifths of which are not only indifferent, but positively prejudicial, from the quantity of heat it absorbs, it happens that the temperature of the mixing-chamber is rapidly reduced below the point at which carbon can decompose vapor of water, and the instant that point is reached the arrival of fresh supplies of steam completes the decline of energy, and the furnace commences forthwith to belch forth from its stack dense volumes of smoke and watery vapor. When in proper action, not a particle of smoke is visible from the stack of a furnace in which wet fuel is burning, and, what is more remarkable, the reäctions are so evenly balanced that no wreaths of watery vapor are observed; while, in the earlier stages of combustion, before the proper temperature in the mixing-chamber is reached, both these products are seen in great abundance.

The language of the inventor, in describing the construction of his furnace for burning begasse, is as follows:

"I build two furnaces, side by side, each nearly square in its horizontal section. Towards the top I draw in the wall in such a manner as to form a kind of dome, with a sufficient opening at the top to feed the begasse. In each furnace-chamber there should be a partition of fire-brick, extending across it from front to back, and rising nearly to the top, dividing it into two nearly equal parts. The main chamber of each furnace should be divided into two parts, upper and lower, by a fire-brick grating about one-fifth the height of the furnace above the hearth, the back end of the grate being a little lower than the front.

"In each furnace, at the front, on each side of the central partition, and immediately under the front end of the grate, should be doors for feeding wood and other dry fuel, and directly under these doors, at the hearth of the lower chamber, should be draught openings, capable of adjustment, to support combustion in the lower chamber. Extending across the back of both furnaces, and opening into both by flues, is a mixing-chamber, into which all the gases from both furnaces enter in a highly heated state, and mix and

LARGE IRON FORGINGS.

Mr. R. Mallet has read to the London Institution of Civil Engineers a paper "On the Coëfficients of Elasticity and of Rupture in Wrought Iron, in relation to the volume of the metallic mass, its metallurgic treatment, and the axial direction of its constituent crystals."

Iron was formerly entirely worked under tilt-hammers; the process of rolling was then introduced; and now, in consequence of modern engineering requirements, masses of iron, of considerable magnitude, were produced by faggoting together, under heavy forge-hammers, from large numbers either of bars or slabs grouped together. The masses were not, however, found to possess ultimate strength in proportion to the number of bars of which they were composed; in fact, it appeared that the strength of the mass became less in some proportion as the bulk became greater. This was admitted as a fact, but no one had hitherto attempted to show experimentally what function of the magnitude was the strength of a given kind of iron, manufactured in a given manner; or how the same forged mass, when very large, differed in strength in different directions, with reference to its form; or how the mechanical part of the process of manufacture of the same iron affected its actual strength, either as a rolled bar or as a forged mass.

Addressing himself to this investigation, the author dealt generally with three points of the inquiry, viz.:

1. What difference did the same large bars of unwrought iron afford to forces of tension and of compression, when prepared by rolling, or by hammering under the steam-hammer?

2. How much weaker, per unit of section, was the iron of very massive hammer forgings, than the original iron bars of which the mass was composed?

3. What was the average, or safe, measure of strength, per unit of section, of the iron composing such very massive forgings, as compared with the acknowledged mean strength of good British bar iron?

We have not space for the illustrative details, but the conclusions deduced were, that practically the iron of very heavy shafts, forged guns, huge cranks, and other similar masses, might be expected to become permanently set and crippled at a trifle above seven tons per square inch, and to give way by fracture at about fifteen tons per square inch by tension, and to completely lose form at pressures of from fifteen to eighteen tons per square inch. Therefore it followed that, allowing a deduction of one-half, as sanctioned by practice, from the elastic limits of tension and of pressure, for the margin of safety, the iron of such forged masses should not be trusted for impulsive strains exceeding about one and three-fourths tons per square inch of tension, and about four and a half tons per square inch of pressure, or for passive tensile strains of three and a half tons per square inch, or for passive pressure beyond nine tons per square inch.

THIN CAST IRON.

At a recent meeting of the Manchester Philosophical Society, Mr. Fairbarn, the President, exhibited two large pans of cast iron, procured from China, where they are used for boiling rice. The metal, which is at the strongest part only one-tenth of an inch in thickness possessed considerable

malleability. The President remarked that the art of making such large castings of thin metal was unknown in England.

STRENGTH OF GUN-METAL.

"We were never so powerfully impressed," says the Liverpool *Albion*, "with the improvements in the manufacture of gun-metal, as during a recent visit to the Mersey Steel and Iron Works, where we witnessed various attempts to burst a two-pounder gun. The experiments took place in a chamber excavated in the sandstone rock, covered over with loose sheets of iron, which, of course, made a considerable rattle when each explosion took place. The gun in question, which is five feet two inches in the bore, and weighs somewhere about four hundred pounds, after being charged with one pound of powder, was filled to the muzzle with one-pound balls, and fired by means of a string. When the smoke had cleared away, it was found that the gun was all right, and that so great had been the force of the explosion that many of the shot were shattered, and others deeply buried in the rock. The gun was again charged, and filled with balls, and a cylinder, or round bar of iron, which projected from the mouth. It was then fired, with equally satisfactory results. The next trial was with one and a half pounds of powder and three cylinders, weighing seventy-six pounds all together. This is a test which few guns are calculated to withstand; but, though the noise of the explosion was very great, the metal of the gun was so tough that it remained uninjured. The weight of the metal was afterwards gradually increased to nearly ninety pounds, with safety.

EXPERIMENTS WITH CAST IRON.

A series of interesting experiments has recently been carried on, under the managemeat of Colonel Eardley Wilmot, Superintendent of the Royal Gun Factories at Woolwich, England, with a view to determine the most suitable variety of iron for casting cannon; and the results have been printed in the form of a parliamentary report. Information regarding the several brands of iron experimented with would be of little interest to our readers, but there is other information in it interesting to all those who work in cast iron, and the substance of this we give, as follows: The general mean tensile strength of 850 specimens of cast iron was 23,257 pounds on the inch; the transverse strength of 564 specimens was 7,102; while the crushing strength of 273 specimens was 91,061 pounds, and the torsion but 6,056.

It was found, during these experiments, that when the specific gravity of cast iron was 7·3, and upwards, it was too hard, and did not possess sufficient elasticity for casting cannon. A marked superiority was the result in bars cast horizontally over those cast vertically. Bars which were cooled quickly were also much stronger than others cooled slowly.

It was also found that, by repeated re-melting of the cast iron, its quality was greatly improved. This effect, however, was not so marked when large masses of several tons were operated upon at once. It is believed that by re-melting, although such impurities as phosphorus, sulphur, and silica, may not be expelled, some of the graphite in the iron is converted into combined carbon, which enables the contraction and crystallization of the metal to be more complete. But if the melted iron is allowed to cool very slowly, the carbon, it is thought by some, is reconverted into graphite,

and the iron becomes soft. Repeated melting, then quick cooling, and horizontal casting, greatly improve cannon, and all articles made of cast iron.

HOW THE ARMSTRONG GUN IS MANUFACTURED.

A visitor to the works, who has never seen an Armstrong gun, must, as he witnesses the successive stages of its manufacture, be sorely puzzled to conceive what it will look like when completed; and scarcely less is the surprise of any one who has seen the finished piece, at the strange shapes which its component parts assume during the various processes. Let us begin at the beginning, and observe the various steps, from first to last, in the creation of the most perfect piece of ordnance the world has ever seen.

Imagine a very long, thin bar of the finest iron, some two inches square, and one hundred and twenty feet in length — that is the basis of a twenty-five-pounder. For convenience in the manufacture, this bore is divided into three pieces, about forty feet in length. A hundred-pounder requires three pieces, each of ninety feet in length. The manufacture commences in the forging shop, a vast, dingy shed, where there is an incessant din of hammers and roaring of mighty furnaces, where blocks and bars of iron lie scattered in seeming confusion on every side — here almost transparent at white-heat, there glowing red-hot; in one corner sending out showers of sparks under the discipline of a huge steam-hammer, in another hissing and sputtering under a stream; where stalwart, grimmy men, with uprolled shirt-sleeves, visors, and leather aprons, are seen looming through the smoke, or, in the full glare of the fires, tossing about red-hot bars with the indifference of salamanders, and making the anvils ring with thirty-Cyclops power.

We fix our eyes on a long narrow furnace, in which lie a number of the iron bars we spoke of. Suddenly the door is opened, and a fierce lurid gleam of light is cast through the shop. One of the men seizes the end of a bar in a pair of pincers, drags it forth, and makes it fast to a roller which stands immediately before the furnace, and the diameter of which is equal to the rough-made tube of a twenty-five-pounder when first rolled. The roller is put in motion — the bar is slowly and closely wound around it, just as one might wind a piece of thread round a reel. The roller being turned on one end, the spiral tube — No. one coil it is termed — is knocked off, restored to white-heat in another furnace, — for it has cooled somewhat in the rolling, — and then flattened down and welded under one of the steam-hammers, till only about half as long as it was. For a twenty-five-pounder, the length of the coil after this process is two and a half feet; and three such coils are welded together to form the tube.

Before that operation is performed, however, each coil is bored in the inside, and pared on the outside, to within a very little of its proper diameter, so that the slightest flaw in the welding, if any exist, may be detected. Having passed this test, a couple of coils, brought to a proper heat by being placed end to end in a jet of flame from a blast-furnace, are welded by violent blows from a huge iron battering-ram. A third coil is added to the other two in the same manner, and the tube is complete. Over this a second tube, which has been prepared just in the same way, is passed while red-hot, and, shrinking as it cools, becomes tightly fastened. This is termed "shrinking on." Over this again is placed a short, massive ring of forged iron, to which the trunnions or handles of the gun are attached.

The breech, which has now to be added, is composed of several iron slabs, something like the staves of a barrel, which are bent into a cylindrical form, and welded at the edges, when red-hot, under the steam-hammer. In the breech, the fibre of the metal runs in the direction of the length of the gun, while in the other parts it winds round and round transversely. This is done to give greater strength to the breech in sustaining the whole backward thrust of the explosion. The breech thus formed is "shrunk on" to the rest of the gun; and to add still more to its strength, two double coils of wrought iron are rolled on with the fibre at right angles to that of the breech underneath. The piece now exhibits very much the appearance of what is called a three-draw telescope — the tube, the trunnion-piece, and the breech representing the three "draws" of the glass when pulled out.

So much for the rough work of the gun; we now come to the finer and more delicate process. Having been pared down on the outside to its proper size, the gun passes to the measurers, who, with an instrument called a micrometer, measure each part with mathematical accuracy. The slightest deviation of any portion from its exact size, even to the fraction of a hair's breadth, is rigidly pointed out, and has to be amended. The boring and rifling of the piece are next performed, in a large, tidy, well-lighted room, where there is no noise, or smoke, or confusion, as in the forging shop. The gun is placed erect in the boring-machine, and revolves gently round the big gimlet, which slowly but surely wends its way downwards, scooping out the superfluous metal from the interior of the tube.

Four pieces can be bored at once by each machine. This is the lengthiest process the gun has to go through. It has to be performed twice, each time occupying six hours. First, the gun is bored to within a $\frac{1}{100}$ of an inch in its proper diameter; and the second time it is finished. The rifling is performed in a turning-lathe, and occupies some five hours. There are thirty-eight fine, sharp grooves, of a peculiar angular shape — "with the driving side angular," in the words of the inventor, "and the opposite side rounded;" and the turn of the rifling is very slight.

Where the touch-hole of an ordinary gun would be, a square hole is cut for the introduction of the vent-piece, or stopper, which, with the breech-screw, completes the gun. The stopper is a circular piece of steel, faced with copper, which fits into the end of the rifled barrel with the most exact nicety. Upon this little piece of metal depends, in a great measure, the efficiency of the gun; because, unless it hermetically closed the cavity, a portion of the explosive force would escape, and the discharge would be weakened. The copper facing of the stopper is prepared with great care. It has to be sharpened with a file after so many rounds, and a duplicate accompanies every gun. The touch-hole runs through the vent-piece down into the chamber of the gun. The breech of the gun receives a powerful hollow screw, which presses against the vent-piece, and is easily tightened or loosened by means of a common weighted handle. When the stopper is out, the gun is a hollow tube from end to end. —*Chambers's Journal.*

PRACTICAL EFFECTS OF THE ARMSTRONG GUN.

The following is a description of the practical effects of the Armstrong gun, as displayed in recent experiments in England, — the target selected being a Martello tower on the channel coast: The guns employed were a forty-pounder of thirty-one cwt., an eighty-pounder of sixty-three cwt., and

a short hundred-pounder, weighing only fifty-three cwt. The distance was one thousand and thirty-two yards, and the projectiles employed were partly solid shot and partly percussion shells. The tower was built of very strong brickwork, the thickness of the walls being seven feet three inches on the land side, and nine feet on the side next the sea. It measured forty-eight feet in diameter at the base, and was upwards of thirty feet high. Like all other Martello towers, it was arranged to carry one heavy gun *en barbette*. The roof, or platform bearing this gun, consisted of a massive vault, of great strength, supported by the walls and by a solid pillar of brickwork occupying the centre of the tower. The chief merit which has been claimed for Martello towers is, that, from their circular form, they deflect all shot which strike them in the curve; but the accuracy of rifled guns has rendered this advantage of small importance, while the exposed condition of the gun on the top would render it entirely useless against arms of precision. The experiments commenced by a few rounds of solid shot from the forty-pounder and the eighty-pounder, and of blind shells from the hundred-pounder, the object being to ascertain the penetration of these various projectiles. The eighty-pounder shot was found to pass quite through the wall, into the tower, piercing seven feet three inches of brickwork; the others lodged in the wall at the depth of about five feet. Live shells were then fired, and with so much effect, that, after eight or ten rounds from each gun, the interior of the tower became exposed to view. The firing was then suspended to enable the commander-in-chief, who was present, to examine the breach, and also to allow of the execution of a photograph. The fire was resumed in the evening, and continued at intervals on the following day. The centre pillar, supporting the bomb-proof roof, was speedily knocked away, but the structure was so compact that the vault continued to stand, and was only brought down by a succession of shells exploded in the brickwork. Nothing could exceed the precision with which these shells were thrown. The broken section of the vault was itself but a small object to hit; but this was done with such unerring certainty that the very spot selected was almost invariably struck. The total number of shot and shell fired against the tower was one hundred and seventy, of which only a small proportion was from the hundred-pounder. The ultimate result was, that the land side of the tower was completely destroyed, and the interior space filled with the *debris* of the vaulted roof. The opposite side was also injured, but the mound of fallen materials saved it from destruction. We may infer from these valuable experiments that no species of masonry or brickwork penetrable by percussion shells will in future be available in fortification. Nor is it conceivable how wooden ships are to withstand the effects of such projectiles. The hundred-pounded gun used on this occasion is probably the most formidable weapon ever yet produced. Its shell, which weighs one hundred pounds, contains eight pounds of powder; and yet the weight of the gun with which this tremendous projectile is discharged is less than that of the ordinary thirty-two pounder, the weight of which is fifty-six hundred weight

THE NEW WHITWORTH GUN.

A short time since, the gun invented by Sir William Armstrong was generally acknowledged to have thrown all former achievements in the construction of artillery into the shade; but within the past year a weapon has been brought out by Mr. Whitworth, of England, which, it is claimed, attains results hitherto considered beyond the range of possibility.

There are two great points as to which Mr. Whitworth's barrels differ from Sir William Armstrong's. In the first place, they are not, as his are, provided with a chamber in which the charge reposes, but are rifled throughout, from breech to muzzle. The great advantage of this is, that any amount of loading, and any length of projectile, can be employed; whereas, in Sir William Armstrong's, the charge has to be invariably accommodated to the size of the chamber. Mr. Whitworth says that there would not be the least difficulty in firing a projectile half the length of the barrel, should occasion require it; and he actually contemplates firing a two hundred pound shot out of his eighty-pound gun, when it is duly furnished with the carriage which is now being prepared for it. In the next place, instead of being fluted with a number of little sharp-edged grooves, the new barrel is a simple hexagon, with its sides made perfectly smooth, so as to offer the least possible resistance to a body passing over their surface, and thus obviating the dangers which might otherwise result from so considerable a pitch of rifling as that which Mr. Whitworth employs. The pitch of rifling in the three-pounder is one inch in forty; and thus the projectile makes one and a half revolutions before leaving the barrel, and the most intense rotatory motion, and, consequently, the greatest accuracy of flight, are thus obtained. Notwithstanding this violent twist in the barrel, which some people have imagined must lead to frequent explosions, Mr. Whitworth has contrived that there shall be extremely little friction. This is managed by the projectile fitting the barrel, and being allowed to slip over its surfaces, instead of being made slightly larger than the barrel, and being thus forced to cut into its edges.

In the Armstrong gun, the projectile, in forcing its way out, drives its leaden coating into the grooves of the barrel. In the Whitworth gun, the projectile glides over the surfaces of the barrel, and passes out with a very inconsiderable degree of resistance. The form of projectile which is found to answer best, and with which the great distances have been accomplished, is an oblong conical bolt, rifled so as to fit the barrel. In the three-pounder it is about nine inches long, and in shape is like a little cucumber with one of its round ends cut off, and six spiral slices cut longitudinally in its rind,—these being, of course, for the purpose of fitting the hexagonal bore. The length of the projectile, however, is not an essential point, and so long as its rifle exactly fits the barrel through which it is to pass, it may be longer or shorter, or a perfect sphere, as convenience or fancy may suggest. When the gun is to be loaded, the breech of the cannon screws off, and the bolt is pushed into the barrel. At its back is placed a tin cartridge, similarly rifled, and so arranged as to protrude slightly from the barrel, till the cannon's breech is again screwed on; so that, when the gun is fastened up, the cartridges line that part of it at which its breech and body join, and prevent the possibility of the slightest escape of air or powder through any interstice that might be occasioned by an imperfect fitting of the screw. It has also the advantage of confining the powder at the moment of explosion, and so saving the gun's metal from the full strain of pressure to which it must otherwise be exposed.

But the cartridge has still a farther use. At the end where it touches the projectile it is furnished with a little lump of lubricating matter, which is disbursed by the explosion over the interior of the barrel, and cleans it for the next discharge, besides effectually preventing the least windage. Two hundred rounds can be fired without the barrel fouling; and the great inconvenience of having to sponge out the barrel after every shot, and of being obliged to carry water with the gun for this purpose, is altogether avoided.

In action, where time is everything, the gain would be enormous; and owing to this, and to the simplicity of its other details, the guns could no doubt easily be fired two or three times in a minute, and their execution must necessarily prove immense. Each of them is fitted with the necessary screws for shifting their aim, and a few turns of a handle brings them instantaneously to bear upon any given point with the utmost nicety, — the whole being easily within the management of a single man.

Some experiments with Whitworth's guns, of different calibres, are thus described in the London *Times:* The three-pounder, which looks more like an elegant telescope than a deadly instrument of destruction, was first fired at three degrees of elevation, and its shot then fell somewhat short of a mile, varying from 1,600 to 1,500 yards, but in no instance deviating more than two yards from the true line of fire. Two shots out of nine actually fell on the line, and five only half a yard on one side. When the three-pounder was raised to twenty degrees of elevation, its range was about 6,600 yards; and out of three shots fired, two fell precisely on two parallel lines, within six feet of one another. The experiments with the twelve-pounder were equally remarkable. At twenty degrees of elevation it ranged from 6,818 to 6,339 yards; at five degrees of elevation, it averaged 2,300, and threw all its shot within two and a half yards of the true line of fire.

Perhaps the most beautiful part of the performance was that in which Mr. Whitworth showed how capitally his bolts could be made to ricochet. The spectators were ranged on the sandy ridges about a hundred yards from the shore. More than a mile and a half away might be descried a little group gathered around the guns; presently came a flash, then an interval of a few seconds, then the rumble of the report, and almost at the same time the sand in front was ploughed up and dashed away right and left, and the bolt might be heard rushing high overhead with a sort of wild scream, and presently marking the spot of its final fall by a tiny splash in the far distance.

Subsequent trials at Southport, with three, twelve, and eighty-pounders, according to the *Times*, surpassed the most sanguine expectations. "The accuracy of fire," it says, "and length of range obtained from trifling charges of powder were so totally beyond what has ever yet been attained, that it is evident we are upon the eve of another revolution in all relating to scientific gunnery, and that even the greatest results which have ever been obtained from the Armstrong gun are likely to be in turn surpassed by Mr. Whitworth's ordnance."

In the firing with the twelve-pounder field-gun, the range was marked out by tall thin poles placed 1000 yards apart for a total distance of 10,000 yards (about six miles), having short sticks placed in the road at every hundred yards between the chief poles. With a twelve-pounder, no experiments having been made expressly to test the range, a six-feet target with a two-feet bull's-eye was hoisted at 1000 yards, to show the accuracy of its fire. Two shots were allowed to lay the gun and find the range, the second of which passed between the target and the pole which held it. Of the eight which were then fired, all went through the target within a space of four feet square, and two through the bull's-eye, which, from the place where the gun was fired, looked scarcely bigger than a man's hand. In this result there was nothing astonishing to those who have seen the Armstrong fired, or even the very best practice made now and then with smooth-bored field artillery.

The charge was twenty-eight ounces of powder, the service charge for an ordinary gun of the same calibre being fifty-six ounces. With the twenty-eight ounces, however, the force and velocity of the shot seemed enormous; the flight was low, the ricochet very great, and nearly always to the right, in the direction of the pitch of the riding. One shot, after passing through the target, first grazed the sand at 2,200 yards, then again at 3000, after which it went on ricochetting along the shore, touching it every 200 or 300 yards, until it buried itself 5600 yards from the place where it was discharged; the elevation of the gun was 1·28, at which the recoil was very little, the explosion much less than that of an ordinary field-piece, and the noise occasioned by the flight of the shot comparatively very slight. One man served the gun with the utmost ease, withdrawing with screw nippers the tin cartridge-case from the breech after each shot. The length of Whitworth's twelve-pounder is about six feet, its bore nearly three inches, and the pitch or turn of the rifling the same as that of all his light guns, one complete turn in forty inches; or, roughly speaking, the shot makes nearly two complete revolutions on its axis before it leaves the gun. The bore of the three-pounder is about three and a half inches diameter. Practice with this three-pounder commenced with ten degrees elevation at 4000 yards, the charge being only seven and a half ounces of powder. The working features of the gun were the same as we have noticed in the twelve-pounder, except that one man worked the gun with much greater ease, firing it, without the least attempt at hurry, four times in less than four minutes. The sound of the projectile also was scarcely audible.

The elevation was then altered to twenty degrees, the same charge of seven and a half ounces being continued for the range of posts, from 6000 to 7000 yards distant. The first shot at this tremendous range struck the sand at 6,760 yards, and only five yards to the left of the true line. The second struck at 6,784, and twelve yards from the true line in the same direction. The third, at 6,720, was sixteen yards out of the line. This deviation to the left was contrary to the usual deviation of the gun, and arose from a rather strong wind which had set in from the sea. The gun was therefore laid more to the right, and threw a fourth shot 6,910 yards distance, and only two yards to the left of the true line! The charge of powder was then increased to eight ounces, and the elevation of the gun raised to thirty-five degrees. The practice then made was really extraordinary. The first shot alighted in the sand at 8,970 yards' distance, only twenty-two yards to the right of the line. The second fell at 8,930 yards, and only ten yards left of the line; the third, 9,059 yards, ten yards to the right; and the fourth at the immense range of 9,164 yards, and twenty-two yards to the right. Midway between the guns and the target the flight of the projectiles over head could just be heard, and no more.

The eighty-pounder was then loaded at five degrees elevation, with twelve pounds of powder, with which charge it threw a ninety-pound projectile, with a fearful roar, a distance of 2,550 yards, when it ricochetted at right angles and buried itself in the sea at an immense distance. A second shot, with the same charge, first grazed the sand 2,620 yards distant from the gun, and only two to the right of the true line. From this point it glanced upwards, but continued a straight course onward, alighting in the sand at a distance of over 6000 yards from the gun. Had this piece been mounted so as to permit of its being fired at a high degree of elevation, there is not the least doubt but that it would have thrown its ponderous shot a distance

of 8000 or 10,000 yards, a distance that has never yet been gained by any gun with a projectile of such weight.

WHITWORTH'S AND ARMSTRONG'S GUNS COMPARED.

The following interesting comparison of the two new guns, — Whitworth's and Armstrong's, — and reflections on the effect of their general introduction on modern warfare, are derived from the London *Army and Navy Gazette:*

If artillery be still in its infancy, it is difficult to determine who are to be its nurses, or under what system of education the tremendous giant is to be brought up. It is obvious, from the recent experiments with Armstrong's and Whitworth's guns, that the attempt made to establish a superiority of range and accuracy on the side of infantry provided with arms of precision over field-artillery, has been unsuccessful; and that the cannon relying on weight of metal can overpower, as before, its ancient enemy, and bids fair to withstand the deadly foes, which hitherto were irresistible against unaided artillery, namely, cavalry charge and dash of infantry. But these advantages are accompanied by certain conditions which almost amount to defects. There is great increase of expense; there is the necessity of special ammunition, being carried in a special way; there is the loss of accuracy in ricochet fire; there is the diminution of power in discharging grape, shrapnel, and common case with effect; and there is the nicety of mechanism, in addition to the requirement, on the part of the gunners, of a certain skill over and above that necessary to handle ordinary field artillery or guns of position. As between Mr. Whitworth and Sir William Armstrong, the case stands thus, so far as we know: Mr. Whitworth has invented a gun which throws its shot further than any engine of war has ever yet been able to force projectiles. Sir W. Armstrong has invented, or adapted, a gun which throws shells and shot with greater precision, and at the same time to a greater range, than any other cannon in the world. We believe, at least, there is no tube, whether it be that of the French rifled gun, or the United States cannon, which combines long range and extraordinary accuracy in the discharge of shell and shot, to such an extent. It will be observed, then, that Mr. Whitworth excels in range and shot, and Sir William Armstrong is unrivalled in the propulsion of shot and shell, — the latter being the more terrible weapon of the two. Mr. Whitworth, however, is content to do one thing at a time. With a three-pounder of thirty-five degrees elevation, and eight ounces of powder, he throws a bolt, which defies gravity and resistance, for five and a half miles, and falls deep into the earth at the end of its flight. That is a great result; and it is evident, if the number of those small pieces were very great, and the object sought to be hit were a stationary mass, they would produce destructive effects. But, as against stone-works, or even earthworks, these small bolts would make little more impression than arrows fired into an archery butt. It is the heavy concussion of large shot fired at low elevations, and with comparatively small charges of powder, which generally produces the most destructive effects on masonry; whilst on riveted earthen ramparts and gabionades no missile is so efficacious as shells bursting continuously in the face of the rivetments. If Mr. Whitworth appeals to his great range alone, we must meet him frankly, and, with the fullest recognition of his great merits and of his very extraordinary achievements, we tell him that, in our opinion, great range of light shot at high elevation is not so formidable by any means as sure practice of heavier shot and shell at much

shorter distance. With considerable diffidence, also, we beg to point out to Mr. Whitworth two difficulties against which he must bring his mechanical genius and his indefatigable resolution to bear: One is, the large allowance to be made by the gunners for the influence of strong side-winds on his bolts; the other, — and a serious one, — the great deflection which occurs in the ricochet after the first graze. Artillerymen will understand how very important it is that richochet should be as much as possible in the true line of fire. It is our conviction that the importance of very long range from guns at high elevation has been very much exaggerated, if the range be obtained by long bolts, and not by shell. Reason about it as mechanics, philosophers, or metaphysicians may, there is some strange repugnance, if not inability, in man to direct implements of destruction against unseen foes. But it is said we must fit our new guns with telescopes. The experiment would be still unsuccessful. If any one doubts it, let him walk to some hill five miles away from a great city, with a good glass in his hand, and select some point for attack. Then let him examine his own sensations, and ascertain whether he would have much confidence in his three-pounder bolt, and would work his imaginary guns with energy against the mark, and he may rest assured that he has at that moment a pretty certain index to the state of his feelings in actual warfare. Until Mr. Whitworth has proved the adaptability of his guns for firing shell, and the power of his larger ordnance to obtain considerable range at low elevations, he may consider that his beautiful principle has not received its full practical development for purposes of warfare; whilst Sir William Armstrong must admit that, as yet, his worthy and liberal rival has beaten him in the matter of range, which is one that must always have most important relations to the power of artillery. Mr. Whitworth has proved that his heavy gun throws a shot which maintains its initial velocity for a great length of time, and we doubt not he will yet get great proportionate range from his eighty-pounder. His lineal accuracy is very great at the lower trajectories of the light guns, and it will, of course, be exceeded by the heavy ordnance.

NEW WAR IMPLEMENTS.

Hotchkiss's New Projectile. — A new form of projectile for rifled cannon has been brought out during the past year by Messrs. Hotchkiss, of Connecticut, and has received favorable attention from the United States War Department. It is made in three parts: the main body of cast iron, with a space or cavity around its centre, into which a belt or jacket of lead, or other soft metal, is cast. On the rear end they place a cap of cast iron, with the front edge sharp like a wedge, which is driven on to the rear end of the shot, and into the belt or jacket of lead. In this condition the shot is introduced into any rifled cannon of suitable bore, and the action of the powder, when the explosion occurs, forces the wedging cap further into and underneath the lead belt, and expands it into the grooves of the gun. This expansion is not allowed to take place except to an extent barely sufficient to tightly fill the grooves of the gun — the extent being perfectly controlled by the depth of the cap, the interior of which drives against the end of the cast-iron body of the shot, and this limits the strain on the gun.

The advantages claimed for the shot, are: extraordinary accuracy; long ranges, with low elevation; light charges of powder, in proportion to the weight of projectile; and immense power of penetration.

Monster Gun. — One of the largest cannon ever constructed has been cast during the past year at the Fort Pitt Foundry, Pittsburg, under the superintendence of Lieut. Rodman, of the Ordnance Department. It was cast hollow, upon a core, through which a stream of cold water was constantly passing, at the rate of about forty gallons per minute: the object being to produce metal of uniform texture, from the equal cooling and contraction of the mass. The core-barrel, which formed the bore of the gun, was removed twenty-four hours after casting, and water, at the same rate as before, was caused to circulate through the cavity, descending along a tube to the bottom of the bore, rising up by another tube, and escaping through a wrought-iron pipe, cast into the spruehead of the gun about fifteen inches from the casting. The metal was entirely cold at the end of seven days after casting, — a shorter time than is required for cooling an eight-inch solid-cast gun. The bore of this gun is fifteen inches in diameter, and thirteen feet long in the cylinder, which is terminated by an ellipsoidal chamber nine inches long, making the total length of bore one hundred and sixty-five inches, or thirteen feet nine inches long. The thickness of metal in the breech is twenty-five inches, and the total exterior length is fifteen feet ten inches. The greatest exterior diameter at the muzzle is 48.1 inches. The weight of the gun is 49,099 pounds. It is to carry a shell of three hundred and fifty pounds, and a solid shot of four hundred and twenty-five pounds weight.

In illustration of the advantage of the mode of casting adopted in this gun, a specimen of cast iron, cut from a shaft cast in the usual way, was recently exhibited at a meeting of the Franklin Institute, Philadelphia. In the middle of the piece, where the iron had retained its heat and softness for the longest time, the contraction of the surrounding parts had caused the metal to assume an open, loose character, whilst the central portion was thrown into groups of spiny formation, resembling frost-work. Experiments made with Rodman's gun at Old Point Comfort, Va., are reported as highly satisfactory.

THE CONSTRUCTION OF ARTILLERY.

The very interesting question of the best method of construction to be adopted for artillery has recently been handled with unusual detail by a body of gentlemen who, it may fairly be presumed, possess peculiar qualifications for forming an authoritative opinion on the point. On the fourteenth of last February, Mr. Longridge, a civil engineer of considerable eminence, read before the London Institution of Civil Engineers a paper on the subject; and so great was the interest excited by his essay, that the discussion which followed it was carried on for five consecutive evenings, being sustained by a large number of the most distinguished authorities on the question, military as well as civil. Although there was, as might have been expected, considerable difference of opinion, often on points of no small importance, among the gentlemen who took part in this lengthened debate, still, the complete ventilation of this momentous question at the hands of such competent authorities cannot but excite great interest. From a printed report of this discussion we derive the following abstract: The one point to which Mr. Longridge has directed his efforts is the construction of a gun which shall be able perfectly to resist the utmost force of the explosive compound which may be used in it; in other words, the manufacture of a gun which gunpowder cannot burst. In order to effect this, it becomes, in the first place, necessary to ascertain, approximately, at least, the actual amount of the

force generated by the explosion of gunpowder, — a point on which artillerists are as yet very far from being completely agreed. Robins, who first attempted its determination, valued it at one thousand atmospheres, or nearly seven tons on the square inch; Hutton, who endeavored to ascertain it by means of the ballistic pendulum, estimated it at from thirteen to seventeen tons; and Captain Boxer, whose method consists in measuring the actual bulk of permanent gas evolved by the combustion of a known amount of gunpowder, arrives at the result of rather more than twenty-two tons. Independently of the great discrepancy between these several estimates, Mr. Longridge declines to receive them, on the ground of the inaccuracy of the methods by which they have been made. In the last method, especially, there appears to be several sources of error; for not only has the heat generated by the combustion of gunpowder never been experimentally determined, but it is also quite possible that the expansion of gases at so extreme a temperature may not altogether be regulated by the law of Mariotte. Further, it presupposes the instantaneous conversion of the whole of the powder into gas. Mr. Longridge accordingly instituted a series of experiments of his own, based upon the determination of the amount of gunpowder required to burst a cylinder of known strength, from which he concluded that the ultimate force of the powder used — government powder — did not exceed seventeen tons per square inch. This amount of force can never, he says, be permanently resisted by a gun made of cast iron, a material whose tensile strength is estimated at not more than eight tons per square inch, especially if, as is generally the case in England, the gun be cast solid, and subsequently bored, since the unequal rate of cooling of the inner and outer parts cannot fail to produce serious flaws in its mass. All the money, therefore, which is now being spent in rifling cast-iron ordnance is simply thrown away. The same objection applies to the construction of a gun by a single casting from any homogeneous material whatever. The only way of attaining the maximum of strength is, to build up the gun, layer by layer, in such a manner that each successive layer, from within outward, shall be in a progressively increasing state of tension. It is on this principle that the guns of Sir W. Armstrong, Mr. Whitworth, and Captain Blakely are made. The method of carrying it out, however, adopted by all these gentlemen, consists in encircling a central tube, of various material, with successive rings of iron, which are either shrunk on by cooling, or forced on when cold by hydraulic pressure. This mode of operation can never, says Mr. Longridge, lead to perfectly satisfactory results. The extreme nicety with which the tension of each successive layer ought to be regulated — the deviation of one five-hundredth of an inch from the required size being sufficient to materially impair the strength of the gun — can never be arrived at by the contraction of a heated ring; and the rings, however put on, must sooner or later be loosened by the repeated shocks of the explosion. The plan proposed by Mr. Longridge is, to wind round a central tube successive spiral layers of steel wire, until the desired strength is attained, — the greatest attention being paid to the exact tension of each successive layer. He does not enter at all into the question of what is the best material for the central tube. On the contrary, his sole object being to exhibit in the most striking light the immense power of resistance given by the layers of wire, he appears purposely to have made the core as weak as he well could. The results of a series of private experiments on a small scale were so encouraging that he constructed a brass cylinder, of about three inches bore and a yard long,

wound round with coils of square steel wire, of the size of one-sixteenth of an inch, the coils being six deep at the breech, and diminishing to two at the muzzle; and, after subjecting it to a severe proof, submitted it, in June, 1855, to the Select Ordnance Committee. The decision not being favorable, Mr. Longridge continued his experiments, employing a cylinder of cast iron instead of brass, and succeeded in producing a gun, weighing only three hundred pounds, which could throw a shot of seven and a half pounds to the distance of a mile, — a result which, he believes, is not attainable by any six-pounder in the service. He further extended his invention to the construction of cylinders for hydraulic presses, and succeeded in combining the two very desirable qualifications of lightness and strength to a degree far beyond anything that has been attained by any other mode of construction.

Such, briefly, are the principal points which were submitted by Mr. Longridge to the meeting. We have already said that in the discussion which followed many of the most distinguished authorities, civil and military, took part. It seems to be generally admitted that, as far as regards mere strength, Mr. Longridge's guns are likely to be superior to any others. Most of the objections which are made to his plan are based upon the difficulty of securing the wire firmly at the breech and the muzzle; points which, says Mr. Longridge in reply, present no real difficulty at all.

Several gentlemen speak up in favor of cast iron as a material for artillery. Mr. Haddan and Mr. Bashley Britten, to whom the task of rifling the existing iron ordnance has been chiefly entrusted, both declare that, for ranges of from three to four thousand yards, the old guns are all that can be desired. They urge, with considerable cogency, that a longer range than this is not practically required. In order to make sure of hitting even a large object at six thousand yards or upwards, it is necessary to throw away in ascertaining the range more shot than can, with a due regard to economy, be spared. Cheapness must be an important element in the calculation. An old iron gun, whose value is not more than £20, can be rifled for thirty shillings, and so enabled to throw shot to a distance of more than three thousand yards; and it is bad economy to spend £250 on an Armstrong twelve-pounder, whose performance is but little if at all superior. Mr. Conybeare and other gentlemen extol the American system of casting iron guns hollow, and cooling them from within outwards, by passing through them a continual stream of cold water, while the outside is kept heated. This method secures the advantage of keeping the outer portion of the gun in a greater state of tension than the inner; and Mr. Conybeare anticipates that the gun of the future will be of cast iron, and manufactured in this manner. But the truth appears to be, that cast iron, though not so utterly untrustworthy as is asserted by Mr. Longridge, cannot be relied upon as a material for artillery. One gun may survive thousands of discharges, and another, made of the same iron, and under the same circumstances, may burst at the first discharge. Sir C. Fox advocates the use of iron alloyed with wolfram or titanium; and Mr. Abel, the chemist to the Ordnance Department, states that a compound far superior in tenacity to ordinary gun-metal may be obtained by mixing copper with from two to four per cent. of phosphorus. But there is little doubt that, as far as is yet known, the only reliable guns are those which are built upon one modification or another of the new principle. Mr. Lancaster says a few words respecting the bursting of his guns in the Crimea, a misfortune which has since then been frequently cited as a proof of the inefficiency of his system. The acci-

dent was entirely owing to the faulty construction of the shells which were at first used. They were made in two parts, and welded together, and the weld being occasionally imperfect, the flame of the explosion penetrated into the shell, which burst in, and of course shattered the gun. Shells made in one piece were at once substituted, and nothing of the sort has since occurred.

In regard to the effect of twist in rifled guns, every artillerist seems to have his own ideas as to the degree of it to be given, varying from Mr. Haddan's one turn in forty feet to Mr. Whitworth's one turn in forty inches; but not one of them takes the trouble to give his reasons for selecting the precise pitch which he has decided to adopt. Mr. Haddan, indeed, believes that a very rapid twist is likely to burst the gun; and Mr. Whitworth says vaguely that it is very desirable to give a very rapid rotation to the projectile; but neither one nor the other cites either facts or theories in support of his view. Mr. W. B. Adams regards rifling merely as a device for correcting the defects of badly constructed projectiles; and as it involves a considerable waste of propelling power, he hopes before long to see it dispensed with altogether, by the employment of more accurately-made shot.

Perhaps the most obvious and striking conclusion that is deducible from the whole of this discussion is, that the science of artillery is as yet in its infancy. There is not a single point of importance on which the most opposite opinions are not held by the most competent authorities. To speculate on the causes which have led to this extraordinary neglect on matters of such vital import would be a task more easy than profitable.

SCIENCE IN THE BATTLE-FIELD.

The following is an abstract of a lecture recently delivered before the Royal Institution, London, by Mr. F. Abel, Director of the chemical establishment of the War Department of Great Britain, "On the recent Applications of Science in Reference to the Efficiency and Welfare of Military Forces."

One of the most important subjects in connection with military equipment, and one which has recently received a very large share of general attention, relates to the changes which have gradually been effected in the nature of material, and the principles of construction, applied to the production of cannon. Until very recently, the materials used for cannon have been only of two kinds — cast iron and bronze, or, rather, the alloy of copper and tin, known as gun-metal. Of these, the latter is by far the most ancient. Guns were cast of bronze in France and Germany about 1370, and from that period until the close of the fifteenth century this material gradually replaced wrought iron, of which guns were constructed in the first instance. An examination of such iron guns of early date as are still in existence — such as the Mons Meg, of Scotland, the great gun of Ghent, and others — shows that the principles involved in their general construction are precisely those which have just been most successfully applied to the production of wrought iron rifled guns in this country. Those ancient guns were built up of stave-bars, arranged longitudinally, upon which wrought-iron rings were shrunk. The very imperfect nature of those structures, arising from the primitive condition of mechanical and metallurgic appliances at that early period, rendered their durability exceedingly uncertain; and it is therefore not surprising to find that compound guns of this class were gradually replaced by cannon cast in one piece. Even the great expense of bronze, as com-

pared with iron, was counterbalanced by the vast amount of time and labor which must have been bestowed on the construction of the old wrought-iron guns.

Although cast iron was applied to the production of shot and other projectiles at the close of the fourteenth century, it was not until about 1660 that cannon were made of this material. In proportion as the facility of its production increased, its application in this direction was gradually extended; but in no country has it ever entirely superseded bronze or gun-metal, which, on account of its superior tenacity, has always been employed for the construction of light field-guns. This alloy possesses, however, some very serious defects, arising principally out of its softness, and its consequent incapacity to resist the injurious effects of rapid firing. Numerous experiments have been made with alloys of copper, and, recently, with other combinations of that metal, with the object of discovering some material at least equal to gun-metal in tenacity, and superior to it in hardness and also in uniformity. Alloys of copper and aluminum have been proposed; but, apart from the present great cost of aluminum, the readiness with which this metal is attacked by alkaline substances, and the powerful corrosive action which portions of the products of decomposition of powder consequently exert upon it, preclude its application to the production of a substitute for gun-metal. The effect of silicon in hardening and greatly increasing the tenacity of copper has also received attention; and there appears little doubt that, the difficulty of producing on a large scale a uniform compound of copper and silicon once overcome, such a material would prove a most valuable substitute for bronze. The effects of a small quantity of phosphorus upon copper are similar to those of silicon; the metal is greatly hardened, its uniformity may be ensured, and its tenacity is also much increased. Copper containing from two to four per cent. of phosphorus will resist a strain of from forty-eight to fifty thousand pounds on the square inch, while the average strain borne by gun-metal is about thirty-five thousand pounds. Uniform compounds of phosphorus and copper can, moreover, be prepared without difficulty upon a large scale. By immersing pieces of phosphorus for a short time in a solution of sulphate of copper, they become coated with a film of the metal, so that they may be safely handled, and thrust beneath the surface of liquid copper before the coating melts; thus the phosphorus is readily combined with the copper without loss.

The great success which has recently attended the construction of malleable iron guns appears, however, to render it doubtful whether any of the compounds above referred to, or others of a similar character, will ever receive employment as materials for cannon. Attempts have been made from time to time, for many years past, to produce forgings of malleable iron of sufficient size for conversion into cannon. The great difficulty of insuring anything approaching uniformity of chemical composition and physical properties in cast iron, and the consequent great variation and uncertainty of the enduring power of guns made of that material, acted as powerful incentives for the prosecution of such experiments. Experience gained during the late war was also unfavorable, partly to the employment of cast iron as the material for the heaviest pieces of ordnance, and partly to the system of casting those hitherto in use.

The attempts made by Nasmyth and others to produce large forgings, sufficiently perfect for conversion into cannon, were, however, uniformly attended with failure, excepting in the instance of a very large gun — thir-

teen-inch calibre — constructed at the Mersey Company's works, which has successfully withstood some severe trials, though even this gun is not a perfectly sound forging throughout. This want of success is ascribed partly to the difficulty of ensuring perfect welds throughout a very large forging, and partly to a change which is gradually effected in the physical structure of the metal by its repeated exposure to a high temperature, and possibly, also, in some measure, by its frequent subjection to powerful concussion. In large masses of wrought iron, which have been built up by welding, the fibrous structure of the metal is always found to have passed over, more or less perfectly, into a lamellar structure, and the strength of the mass thus becomes very considerably diminished.

While unsuccessful attempts to construct cannon of large masses of malleable iron were still in progress, Mr. Mallet, Captain Blakeley, and others, who had given the subject of the construction of cannon of large size their serious attention, and had applied mathematical reasoning to its elucidation, had arrived at the conclusion that the true system to be followed was that of constructing cannon of several parts, combined in such a manner as to render every portion of the metal available in resisting, by its tenacity and elasticity, the strain exerted upon the gun by the explosion of powder. The method of construction proposed by those gentlemen consisted in preparing, in the first instance, cylinders (or rings, to be afterwards braced together), and in shrinking upon these other rings, of which the internal diameter was somewhat less than the external diameter of the first rings or the cylinder. The latter are thus placed in a state of compression, while the external rings are in a state of tension. Other rings are again shrunk upon the outer ones, according to the size of the gun and the strain which it has to bear. In this way the whole of the metal composing a heavy gun or mortar is arranged in a condition most favorable to the effectual resistance of a sudden strain applied from the interior. A gun constructed on this plan, by Captain Blakeley, has exhibited very great enduring powers. Two enormous mortars have also been constructed by Mr. Mallet on the same principle; and, although the trials with one of these were only partially successful, the correctness of the principles above referred to were in no way impugned by the results obtained.

The methods adopted for the production of the beautiful rifle-gun invented by Sir William Armstrong, which is rapidly replacing the old bronze field-guns, afford an interesting illustration of the application of the above system to the construction of very light and durable cannon. This gun consists essentially of rings partly welded together, so as to produce a cylinder or barrel of sufficient length, and partly shrunk one upon another, so as to impart the requisite strength to the structure. The rings themselves are from two to three feet in length, and are formed out of long bars, which are coiled up, when at a red-heat, into spiral tubes, and afterwards welded into solid rings or tubes by a few blows from the steam-hammer, applied to one end of the heated coil, while in a vertical position. The rings are united, to form the barrel of the gun, by raising to a welding-heat the closely proximate extremities of two rings, placed end to end, and then applying a powerful pressure to the cold ends of the rings. In the large guns, a second layer of rings is shrunk on to the first set, or barrel, throughout the length; but in the smaller guns it is only behind the trunnions that two additional rings are shrunk on, one over the other. The outer ring is exactly like those already described; but the intermediate one is prepared by bending two iron slabs into a

semi-cylindrical form, and then welding them together at the edges. In this way a cylinder is obtained in which the fibre of the iron is arranged longitudinally, instead of transversely as in the other rings. This arrangement is adopted because that part of the gun has to sustain the principal force of the thrust upon the breech, on the discharge. It is into this portion that the breech-screw — made of steel — fits, by means of which a movable plug of steel, provided with a soft copper washer, is pressed up against the end of the barrel when the gun has been loaded. The breech-screw being hollow, the charge is introduced through it into the gun, on the removal of the plug.

This gun, built up of so many pieces, accurately welded, and turned, and fitted, with its thirty or forty grooves, its neat lever arrangement for working the breech-screw, its admirable sights for giving direction, and various other arrangements, contrived so as to render it a most complete and perfect weapon, is undoubtedly very costly as compared with the ordinary cast-iron gun. But, owing to the admirable system of manufacture, and the beautiful mechanical appliances brought to bear upon the production of each part, the original cost of the gun has already been very much diminished. On comparing the price of a twelve-pounder gun with that of a bronze gun of the same calibre, which it has now superseded, the latter is found to be about double the expense. The price of iron used for the manufacture of the Armstrong gun is nineteen pounds per ton. It is the best description of malleable iron, bearing a tensile strain of about seventy-four thousand pounds on the square inch. The present cost of a twelve-pounder gun, weighing eight hundred weight, is about ninety-three pounds. The value of gun-metal is about one hundred and twenty-five pounds per ton; and the cost of a twelve-pounder gun of this material, weighing nineteen hundred weight, is one hundred and seventy-five pounds ten shillings. Of the latter, it may be said, that when no longer serviceable it may be recast, while an old Armstrong gun cannot be reconverted into a new one. But, on the other hand, the average number of rounds which can be fired from the old gun before it is unserviceable scarcely exceeds one thousand; while the limit to the power of endurance of the Armstrong gun is not yet known. Between five and six thousand rounds have been fired from one, without any vital injury to the gun.

While these important results have been obtained with guns of wrought iron, built of rings, others, scarcely less valuable, have attended the application of materials, varying in their nature between steel and malleable iron, to the production of light guns, cast in one piece. M. Krupp, of Essen, was the first to produce masses of cast steel of sufficient size for conversion into cannon. A twelve-pounder gun, cast of this material, was experimented upon in this country several years ago, and exhibited the most extraordinary powers of endurance, having withstood the heaviest proofs without bursting. Similarly good results were obtained with cast steel in France and Germany, and it is now applied to the construction of the rifled field-guns in Prussia. A cast material, somewhat similar in character to this steel of M. Krupp, and to which the name of homogeneous iron has been given, has recently received most successful application in the hands of Mr. Whitworth, not only to the production of the barrels for his rifle small arms, but also to the manufacture of his beautiful rifle-cannon. The smaller cannon are cast in one piece, and then forged to the required form. The heavy guns — eighty and hundred pounders — consist, however, of cylinders of homogeneous iron, upon which hoops of fibrous iron are forced by hydraulic pres-

sure, the breech portion receiving hoops of puddled steel. The small Whitworth guns undoubtedly possess the great advantage of simplicity of construction over the compound guns just described; but the present great expense of the material gives the latter the advantage in point of cost. There can be little doubt, however, that the facilities for obtaining products of this description will increase with the demand; and there appears no reason why the process of Mr. Bessemer, which has recently been applied with great success to the conversion of iron of good chemical quality into excellent cast steel, upon a very considerable scale, should not be resorted to for the production, at a moderate cost, of masses of cast steel, or a material of a similar character, of sufficient size for conversion into cannon of all sizes but those of the heaviest calibre, which it will, perhaps, always be found most advantageous to construct of several pieces, upon the principles just now referred to.

The improvements effected in the construction of fire-arms have rendered indispensable a careful revision of the descriptions of gunpowder hitherto used, which has already led to the modification of several important points in the manufacture of powder, whereby a greater uniformity in the action of the latter is ensured, and its explosion is regulated with especial regard to the double work which it now has to perform in the greater number of rifled arms, namely, that of propelling the projectile, and of expanding it into the grooves of the rifle.

Considerable attention has been devoted in different continental states, during the last few years, to the application of the different forms of electricity to the discharge of mines. The many serious inconveniences attending the employment of voltaic batteries for that purpose in the field, have led to the use, with considerable success, of the arrangements contrived by Ruhmkorff and others for the production of powerful electro-magnetic currents. The application of the induction-coil machine, with appropriate fuse arrangements, for the ignition of the mine by means of the spark, led to a very great reduction in the size of the battery required even for extensive operations. The necessity, however, of still using a battery, and the great liability to injury of the induction apparatus, have rendered the advantage to be attained by their employment somewhat questionable. In Austria very important results are said to have been obtained by the employment of frictional in the place of voltaic electricity. A very portable arrangement of a plate-electric machine, with Leyden jars, and a small stove to protect the apparatus from damp, has been employed with success in some extensive operations, as many as one hundred charges having been fired simultaneously by its means. Professor Wheatstone and Mr. Abel have carried on numerous experiments on the application of electricity in this direction; and, at the suggestion of the former, attempts were made to employ the electricity obtained by induction from permanent magnets. No difficulty was experienced in igniting a single charge by its agency; but it was found that the ignition of more than one charge could not be effected with certainty by the employment even of the most powerful magnets and the use of fuses containing very sensitive compositions. Eventually, a fuse arrangement was contrived and a composition prepared by Mr. Abel, with the employment of which the ignition of several mines could be effected with certainty, by means of one of the small magnetic arrangements employed by Mr. Wheatstone in his portable telegraphs; and an ingenious combination of several such magnets, arranged in a form very portable and readily worked by any soldier, can be

applied with equal certainty to the discharge of a considerable number of mines. The great element of success in the fuse-composition employed is to be found in the circumstance that it combines a high degree of sensitiveness with considerable conducting power. The substitution of the magnet for the voltaic and other arrangements hitherto used will greatly facilitate mining operations; the soldier requires but little instruction in its use; with ordinary care it is not liable to derangement; it is very transportable, and ready for application at the shortest notice.

In connection with submarine operations, vulcanized India-rubber bags have become valuable substitutes for the wooden and metal receptacles hitherto employed for the charges of powder. The numerous applications which India-rubber, especially in its vulcanized form, now receives in connection with military equipments, render it a most indispensable material. Thus it has been applied to the preparation of waterproof linings for powder-barrels, waterproof cases for cartridges, convenient holders and waterproof coatings for percussion caps. It is used in the form of springs and buffers in connection with gun-carriages and the beds of heavy mortars; ambulance wagons are supplied with efficient and easily applicable springs of India-rubber; and one of the most important additions recently made to the comfort of troops has been the general supply to them, when on active service, of waterproof clothing and covers, to be used in camp.

The protection of camp-erections from fire has also received attention, with successful results. A cheap and ready mode of applying a coating of insoluble silicate of lime and soda to the surface of camp huts, whereby very important protection against fire is attained, received application a few years ago; and quite recently a method has been devised, by Mr. Abel, of impregnating tent-cloth with silicates to such an extent as effectually to prevent fire from spreading, when applied to any portion of it, and in such a form as to enable them to resist the solvent effects of drenching rains.

The application of soluble silicates to the preparation of very porous artificial stone has enabled Mr. Ransome to produce portable filters, by the aid of which the soldier may frequently be enabled to partake of water which otherwise would be unfit for use. A still more efficient portable filter is now, however, prepared of carbon, in a porous condition, which not only has the property of retaining the mechanical impurities of water in its passage through it, but also will purify it to a very considerable extent from injurious organic matters and gases which it may contain.

One of the most important improvements which has yet been effected in the purification of water, and one which has already received important application in connection with the military service, is presented in the apparatus contrived by Dr. Normandy for the preparation of wholesome and pleasant water from sea or other water unfit for consumption. The apparatus consists, in the first instance, of a great improvement on the condensing arrangement contrived by Sir T. Grant, which has been for some time used in the navy. The heat abstracted from the steam first consumed is applied to the distillation of a second similar quantity of water, and the arrangement employed for condensing this second product is of such a nature as to ensure a very gradual but continuous replacement of the condensing water. In this manner the latter becomes sufficiently heated, before it passes out of the apparatus, to part with the gases which it contains in solution, and which are made to pass into the distilling apparatus and mix with the steam. The condensed product is thus thoroughly aërated; it is then, finally, made to

pass through a charcoal filter, which completely deprives it of the disagreeable empyreumatic flavor always possessed by distilled water. Independently of the applications which this apparatus is receiving to the supply of ships with water, it has proved very valuable in readily and continuously producing large quantities of wholesome water for the supply of troops at stations where the only water procurable was unfit for consumption.

The important subject of the economical supply of well-cooked and palatable food to troops in barracks and on active service, which had been considerably neglected previous to the late war, has received great attention on the part of Captain Grant; and the results of his labors in this direction have been the production of most efficient cooking-ranges for barracks, and equipments for cooking in the field. By the employment of the range, with oven attached, which has been contrived by him, and is used at Aldershott, Woolwich, and other military stations, the cost of cooking for a large number of troops — eight hundred to one thousand being supplied with food from one range — has been reduced to a halfpenny per man per week; and, by further improvements which Captain Grant is just carrying out, it will still be subject to considerable reduction. The food is, at the same time, cooked in various ways, by means of the oven and other appliances. An arrangement has been devised by Captain Grant, and used by troops with great success, for cooking in the field in long cylindrical boilers, which are so disposed over trenches dug for the purpose that, with a very small consumption of fuel, well-cooked food may be supplied from eight of them, in between two and three hours, sufficient for eight hundred men. These kettles are of such a form that they may also be made to serve the purpose of pontoons in the construction of bridges.

The subjects briefly discussed in this discourse can only be regarded as examples of the many directions in which every branch of science has recently received application in connection with the military service.

PROPERTIES OF GUNPOWDER.

Mr. Fairbairn, F. R. S., has communicated to the Philosophical Society of Manchester the following results of "An Experimental Inquiry into the Effect of severe Pressure upon the Properties of Gunpowder." During the late war, the author received from the government authorities different samples of gunpowder, for the purpose of submitting them to severe compression, in order to ascertain the effect of close contact between the particles upon its explosive properties. At the government works there is no machinery of sufficient strength to give a pressure of more than five thousand to six thousand pounds per square inch; and as it was considered advisable to test the quality of the powder under the influence of greatly increased pressure, the author was requested to compress it in an apparatus of his own, calculated to effect its condensation under a force of more than sixty thousand pounds per square inch. By carrying the pressure in this way far beyond the ordinary limits, it was expected that the precise influence of compression on the properties of the powder would be more clearly and accurately exhibited.

The samples of powder were placed in a wrought-iron box, and compressed by a lever, acting upon them by a solid piston, with a force varying from thirty-eight thousand to sixty-seven thousand pounds per square inch in the different specimens. When taken from the apparatus, the powder

was found to have been consolidated into cylinders of one and a quarter inches in diameter, with smooth, polished surfaces, every trace of its granular character having disappeared.

From the Report of Mr. Abel, the chemist of the War Department, we learn that the specific gravity of the specimens was increased by the pressure, but not to so great an extent as might have been expected.

The specimens, having been granulated, were then burned, and it was found, on comparing the results with those of similar experiments on ordinary press-cake, that the amount of residue left by the compressed powders, after ignition, was greater in proportion as the pressure was increased. This increase of residue is probably to be attributed to the more gradual combustion and the diminished intensity of heat generated by compressed powder.

Experiments were then instituted to determine the amount of charcoal left unconsumed in the residue. They showed conclusively that the condensation of the powder had caused a more perfect chemical action in combustion, as the per-centage of carbon was considerably diminished in the compressed powders. Nitric acid was very carefully searched for in the residues of the compressed powders, but none could be detected, although in ordinary gunpowder a portion of the acid of the saltpetre always escapes decomposition.

An important objection to the application of increased pressure in the manufacture of gunpowder, notwithstanding the more intimate mechanical mixture of its constituents, is, that the quantity of the residue left after combustion is increased, and a larger proportion of powder escapes ignition altogether when a charge is fired from a gun. If, however, larger quantities were submitted to compression, it is probable that the closer contact of the particles might be found to act beneficially, and a powder be produced of an improved and stronger quality, resulting from a judicious application of increased pressure and a more perfect system of granulation. — *Mechanics' (London) Magazine.*

Mr. Lynall Thomas, in a communication to the Royal Society, says: Since the year 1797, when Count Rumford made his experiments for ascertaining the initial force of fired gunpowder, an account of which appears in the *Philosophical Transactions* of that year, very little light has been thrown on the subject. Count Rumford's experiments, valuable in many respects, afforded, indeed, nothing conclusive respecting it. The object of the present paper is to show the unsatisfactory nature of the present theory of the action of gunpowder, and to point out some of the principal errors upon which this theory is based. For this purpose, the results of various experiments made by the author, and which were repeated in the presence of a select committee at Woolwich, are described and explained. These experiments are held by the author not only to afford complete evidence of the unsoundness of the present theory, but as sufficiently conclusive to serve as the basis for the formation of a new set of formulæ, both correct and simple, in place of those at present in use. The initial action of the fired charge of powder upon the shot, the first movement of the shot itself in the gun, and the force exerted upon the gun by different charges of powder, and, therefore, the actual strength of metal required by the gun, are circumstances which, as the author believes, have not only been misunderstood, but for which laws have been assigned directly opposed to the truth. As an instance of this, the hitherto received theory supposes that when a shot is forced from a

gun it acquires its velocity gradually, from the pressure of the elastic fluid generated by the fired powder acting upon it through a certain space. It is also supposed that the initial pressure of the elastic fluid is the same in all cases,—the quantities of powder being proportional,—whether the gun from which the shot is fired be large or small; so that the larger the calibre of the gun, the slower the first movement of the shot is supposed to be.

The result of the following experiment is given to prove that the first of these propositions is incorrect. The author placed a cast-iron shot, three inches in diameter, and three pounds fourteen ounces in weight, upon a chamber half an inch in diameter and half an inch deep. This chamber was formed in a block of gun-metal, and contained, when filled, one dram of powder. Upon lighting the powder, the ball was driven to a height of five feet six inches. When the ball was placed one-eighth of an inch over the chamber, the charge failed to move it. From this it is inferred that the first force of the powder is an impulsive force, that is to say, it imparts to the shot at once a finite velocity. In order to place the matter beyond a doubt, and to ascertain the relative force of different quantities of powder, the author caused a chamber to be made similar in form to, but of twice the linear dimensions of the former; he then placed a cast-iron ball, of six inches in diameter, upon the orifice of this chamber, which was filled with powder; upon firing the latter, the ball was driven up to a height of eleven feet; that is to say, to double the height of the smaller. The state of the metal in which the chamber was formed also showed the increase of the initial force of the powder. This is considered to be sufficient proof that the last two of the above-mentioned propositions are as incorrect as the first. Assuming the initial force of the powder to be of an impulsive nature, it is not difficult to understand the increase of force shown in the last-named experiment, inasmuch as a certain time being required for the complete conversion of the powder into an elastic fluid, a quantity contained in a chamber of a similar form, but of greater linear dimensions than another, must ignite in a less comparative time, the linear dimensions increasing in the ratio of the first power, and the quantity of powder increasing in the ratio of the third power, so that the flame will traverse a larger quantity in comparatively less time. Thus it appears that the powder which inflames more rapidly has a much greater initial force, being more concentrated in its action; a quick burning powder, therefore, is better for ordnance of small length, such as mortars and iron howitzers. The different results produced by powder of different quality have, according to the author, been entirely overlooked in the hitherto received theory. This theory, which considers the secondary force, namely, the elasticity of the fluid only, and takes no account whatever of the enormous impulsive or initial force produced by the sudden conversion of the powder into an elastic fluid, is that which regulates the system upon which ordnance are at present constructed; hence the reason why large guns are so liable to burst—so much so, that it has been said that no gun larger than a thirty-two pounder is safe to fire.

From the variety of experiments made by the author, he arrives at the conclusion that when powder is of the same quality, and confined in chambers of similar form but of different sizes, the initial force varies, within certain limits, in the ratio of $\frac{w^{\frac{4}{3}}}{w'}$, where w is the weight of the powder, and w' of the ball. Thus, were this new theory recognized, the question of the increase of strength, with increased thickness of metal, would wear an

entirely new aspect. So far from the metal in large guns diminishing in strength in the proportion assumed, it will be a matter for inquiry how it resists the great strain to which it is subjected, rather than why it yields; for we find, from the experiments described above, that a sixty-eight pounder gun, which has a calibre of twice the diameter of a nine-pounder gun, must, when fired with the same proportionate charge of powder as the latter, continually be subject to as great a strain as the latter would suffer if always fired with the proof-charge, which is three times the quantity of the ordinary service-charge. — *Proc. Royal Soc.*

THE DENSITY AND TEMPERATURE OF STEAM.

We extract from the London *Engineer* the following account — read before the British Association for the Advancement of Science, by William Fairbairn, F. R. S. — of some researches to determine the density of steam at all temperatures:

I propose to give a short sketch of an apparatus and the results of the earlier experiments which, in conjunction with my friend Mr. Thomas Tate, I have been investigating by direct experiments, with the intention of determining the law of the density of steam and other condensable vapors; and thus to solve a hitherto almost untouched problem by an experimental method, which will verify or correct the theoretical speculations in regard to the relation between the specific volume and temperature of steam and other vapors. The experiments are being conducted, it is believed, upon an entirely novel and original principle, and one which is applicable at any temperature and pressure capable of being sustained by glass vessels.

For a perfect gas, the law which regulates the relation between temperature and volume is known as Gay-Lussac's or Dalton's law, and is expressed by the equation

$$(1.) \qquad \frac{V \times P}{V1 \times P1} = \frac{458 + t1}{458 + t}.$$

Now, density of steam has been determined with accuracy by direct experiment at the temperature of two hundred and twelve degrees — and at that temperature only — by the method of Dumas. At two hundred and twelve degrees Fahrenheit its density is such that its volume is one thousand six hundred and seventy times that of the water that produced it. Substituting these values of volume, temperature, and pressure, we get for the volume of steam from a unit of water at any other temperature,

$$(2.) \qquad V = \frac{1670 \times 15}{670} \times \frac{458 + t}{P},$$

$$\text{Or, } V = 37\tfrac{1}{3}\,\frac{458 + t}{P}$$

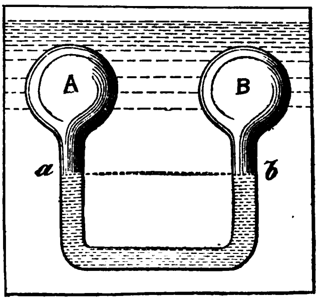
This is the well-known and received formula from which all the tables of the density of steam have hitherto been deduced, and on which calculations on the duty of steam-engines have been founded. Up to the present time, however, this formula has never been verified by direct experiment, nor are the methods hitherto employed in determining the density of gases and vapors applicable in this case, except at the boiling temperature of the liquid at the ordinary atmospheric pressure. But, on the other hand, theoretical

speculations throw considerable doubt on the accuracy of the above formula when applied to steam and other condensable vapors. Several years ago, Dr. Joule and Professor William Thomson announced, as the result of applying the new dynamical theory of heat to the law of Carnot, that, for temperatures above two hundred and twelve degrees Fahrenheit, there is a very considerable deviation from the gaseous laws in the case of steam. Later, in 1855, Professor Maquorn Rankine has given a new theoretical formula for the density of steam, independent of Gay-Lussac's law, and confirmatory of Professor Thomson's surmise. But as yet these speculations need the evidence and verification of direct experiment.

The density of steam is ascertained by vaporizing a known weight of water in a glass globe of known capacity, and noting the exact temperature at which the whole of the water becomes converted into steam. From these three elements — volume, weight, and temperature — the specific gravity is known. But in pursuing this method, these two difficulties must be overcome: First, the pressure of the steam renders it necessary that the glass globe should be heated in a strong, and consequently opaque, vessel; second, as steam rapidly expands in volume for any increase of temperature, beyond the temperature of saturation, it would, in any case, be impossible to decide by the eye the temperature at which the whole of the water became vaporized. The temperature of saturation, or temperature at which the whole of the moisture is converted into steam, while no part of the steam is superheated, must be determined with the utmost accuracy, or the results are of no value.

The difficulties thus resolve themselves into finding some other test of sufficient accuracy and delicacy to determine the point of saturation. This has been overcome by what may be termed the saturation gauge; and it is in this that the novelty of the present experiments consists.

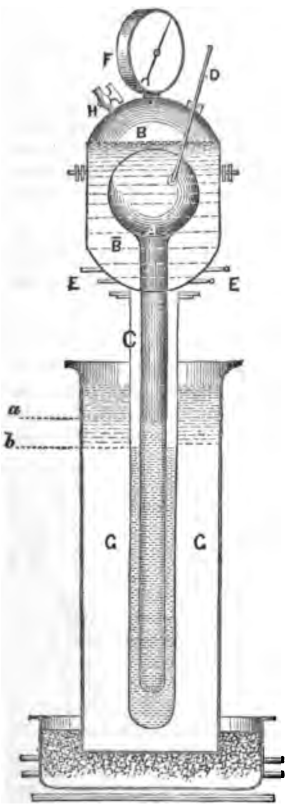
To illustrate the principles of the saturation gauge, suppose two globes, A and B (Fig. 1), connected by a bent tube containing mercury at *a b*, and placed in a bath in which they can be raised to any desired temperature. Suppose a Torricellian vacuum to have been created in each globe, and twenty grains of water to have been added to A, and thirty or forty grains to B. Now, suppose the temperature to be slowly and uniformly raised around these globes; the water in each will go on evaporating at each temperature, being filled with steam of a density corresponding to that temperature, and the density being greater as the temperature increases. At last a point will be reached at which the whole of the water in globe A will be converted into steam; and at this point the mercury column will rise at *a*, and sink at *b*. This is the saturation test, and the cause of its action will be easily seen. So long as vaporization went on in both A and B, and the temperature was maintained uniform, each globe would contain steam of the same pressure, and the columns of mercury, *a* and *b*, would remain at the same level. But so soon as the water in A had vaporized, and the steam began to superheat, the



pressure in A would cease to remain uniform with the pressure in B, and the mercury column would at once fall, and thus indicate the difference. The instantaneous change of the position of the mercury is the indication of the point at which the temperature in the bath corresponds with the saturation point of the steam in A.

To show the delicacy of this test, I may instance that, at two hundred and ninety degrees Fahrenheit, the mercury column would rise nearly two inches for every degree of temperature above the saturation point, as the increase of pressure arising from vaporization is twelve times that arising from expansion in superheating at that point, and a similar difference exists at other temperatures.

The apparatus, as employed for experiment, varies according to the pressure and other circumstances of its use. Fig. 2 represents one of the arrangements which has been employed with success. It consists of a glass globe of about seventy cubic inches capacity, in which is placed, after a Torricellian vacuum has been formed, the weighed globule of water. The globe, with the stem, is shown at A; this is surrounded by a copper boiler, B B, prolonged by a stout glass tube, C, enclosing the globe stem. This copper boiler forms the water and steam bath through which the globe is heated, and, in fact, corresponds to the second globe, B, in the former figure. The fluctuating mercury column, or saturation gauge, is placed at the bottom of the tube, C, and the saturation point is indicated by the rise of the inner mercury column, *a*, and the fall, at the same time, of the outer mercury column, *b*. As soon as the whole of the water in the globe A is evaporated, there is an instantaneous rise of the inner mercury column to restore the balance of pressure, and that progressively with the rise of temperature.



As an auxiliary apparatus, the boiler is provided with gas-jets, E, to heat it, and with an open oil bath, G, to retain the glass tubes at the same temperature as the boiler; and this oil bath is placed on a sand bath and also heated with gas. A thermometer, D, registers the temperature, and a pressure-gage, F, the pressure of the steam; and a blow-off cock, H, serves to reduce the temperature when necessary. A number of results have already been obtained, but they are not yet sufficiently advanced to be made public. The following numbers have been, however, approximately reduced from the theoretical formula above, and the experimental

results may illustrate the use of this method of research. The most convenient way of expressing the density of steam is by stating the number of volumes into which the water of which it is composed has expanded. Thus, one cubic inch of water expands into one thousand six hundred and seventy cubic inches of steam at two hundred and twelve degrees Fahrenheit; into eighteen hundred and eighty-two cubic inches at two hundred and fifty-one degrees, and into four thousand cubic inches at three hundred and four degrees, and so on. In this way, the following numbers have been computed:

Temperature.	Volume of steam. By formula.	By experiment.
244°	1,005	896
245°	969	890
257°	790	651
262°	740	680
268°	680	633
270°	660	604
283°	240	490

These determinations, at pressures varying from ten pounds to fifty pounds above the atmosphere, are not accurate reductions from the experimental results, but only approximations. But they uniformly show a decided deviation from the law for perfect gases, and in the direction anticipated by Professor Thomson, the density being uniformly greater than that indicated by the formula. I hope, by the time of the next meeting of the association, with the assistance of my friend Mr. Tate, to be enabled to lay before the section a series of results which will fully determine the value of superheated steam, and its density and volume compared with pressure at all pressures, varying from that of the atmosphere to five hundred pounds on the square inch.

THE ATMOSPHERIC TELEGRAPH.

The Atmospheric Telegraph, or device for transmiting small packages through air-tight tubes by atmospheric pressure, which was attempted to be introduced in this country some years since by Mr. Richardson, of Boston, has been recently put into practical operation by the International Telegraph Company of London. Their chief office in that city has been for some time in working communication not only with the Stock Exchange, but also with all the subordinate telegraph stations in the outskirts of London, and written messages are constantly transmitted through the tubes — thus avoiding the necessity of repeating each message. "We witnessed," says the London *Times*, "the apparatus doing its ordinary work the other day in the large telegraphic apartment of the company in Moorgate Street. Five metal tubes, of from two to three inches in diameter, are seen trained against the wall, and coming to an abrupt termination opposite the seat of the attendant who ministers to them. In connection with their butt-ends other smaller pipes are soldered on at right angles; these lead down to an air-pump below, worked by a small steam-engine. There is another air-pump and engine, of course, at the other end of the pipe, and thus suction is established to and fro through the whole length. Whilst we are looking at the largest pipe we hear a whistle; this is to give notice that a despatch is about to be put into the tube at Mincing Lane, two-thirds of a mile distant. It will be necessary, therefore, to exhaust the air between the end we

are watching and that point. A little trap-door — the mouth of the apparatus — is instantly shut, a cock is turned, the air-pump below begins to suck, and in a few seconds you hear a soft thud against the end of the tube; the little door is opened, and a cylinder of gutta-percha, encased in flannel, about four inches long, which fits the tube, but loosely, is immediately ejected upon the counter; the cylinder is opened at one end, and there we find the despatch.

"Now it is quite clear that it is only necessary to enlarge the tubes and to employ more powerful engines and air-pumps in order to convey a thousand letters and despatches, book parcels, etc., in the same manner. And this the company are forthwith about to do. At the present moment the contract rate at which the mail-carts go is eight miles per hour. The Pneumatic Company can convey messages at the rate of thirty miles an hour, and this speed can be doubled if necessary.

"The company are also about to lay down a pipe between the Dock and the Exchange, for the conveyance of samples of merchandise, thus practically bringing the Isle of Dogs into Cornhill; and for all we know this invention may hereafter be destined to relieve the gorged streets of the metropolis of some of its heavy traffic.

"At the station of the International Telegraph Company, in Telegraph Street, the pipes wind about from room to room, sufficient curve being maintained in them for the passage of the little travelling cylinder which contains the message, and small packages and written communications traverse almost as quickly in all directions as does the human voice in gutta-percha tubing, to which in fact it is the appropriate addendum."

THE CLEARING OF DRAINS AND WATER-COURSES.

Messrs. Easton & Amos, of London, have patented a curious method of adapting to some convenient part of a drain, sewer, or water-course, a grating, of peculiar construction, whereby any extraneous solid matters, such as weeds, pieces of wood, brickbats, stones, the dead bodies of animals, or other substances, may be arrested in their progress, and removed, so as to prevent them from blocking up the water-course and stopping the flow of the water. To this end a chamber or recess is constructed at some convenient part of the drain, sewer, or water-course, and made to extend across it from side to side. In this chamber is mounted a movable grating in such a manner as to extend transversely across the whole of the water-way. The grating is to be formed of a suitable number of endless chains, connected together laterally in any convenient manner, and provided with projecting pins, points, or hooks. Or a number of short bars, similarly provided with projecting pins, may be jointed together in an endless series, so as to form an endless grating, which is to be passed round wheels or rollers mounted in the chamber or recess. This endless chain or grating should not be placed vertically, but at an inclination to the line of the drain or sewer. It will be understood that the water and liquid matters will pass freely through the endless chain or grating, but that solid matters of any great size or dimensions, or that would be likely to cause an obstruction in the water-course, will be arrested by the grating, and by causing the same to rotate (by communicating motion to the wheels or rollers on which the endless chain or grating is mounted), the pins, points, or hooks attached to the grating will be caused to lift up such solid matters out of the chamber formed in the drain, and deposit them in some receptacle provided above for that purpose.

NEW MICROMETER FOR MEASURING LARGE DISTANCES.

At a recent meeting of the Royal Astronomical Society, England, Mr. Alvan Clark, of Boston, Mass., exhibited a micrometer, invented by himself, which is capable of measuring with accuracy any distance up to about one degree. It is also furnished with a position-circle. Its character is essentially the same as that of the parallel-wire micrometer; but it has some peculiarities, not, it is believed, previously introduced, and on which its wide range depends. The most remarkable of these peculiarities consists in its being furnished with two eye-pieces, composed of small single lenses, mounted in separate frames, which slide in a groove, and can be separated to the required distance. A frame carrying two parallel spider-lines, each mounted separately with its own micrometer screw, slides in a dovetailed groove in front of the eye-pieces; and, by a free motion in this frame, each web can be brought opposite to its own eye-lens. In using this micrometer, the first step is to set the position-vernier to the approximate position of the objects to be measured. Then the eye-lenses are separated till each is opposite to its own object. The frame containing the webs and their micrometer screws is then slidden into its place; and, the webs having been separated nearly to their proper distance by their free motion in the frame, they are placed precisely on the objects by their fine screws, the observer's eye being carried rapidly from one eye-lens to the other a few times, till he is satisfied of the bisection of each of the objects by its own web. The frame is then removed for reading off the measure by means of an achromatic microscope, on the stage of which it is placed. One of the webs is brought to the intersection of cross-wires in the eye-piece of the microscope; and by turning a screw, the revolutions of which are counted, the frame travels before the microscope, and the other web is brought to the intersection of the cross-wires. The parts of a revolution are read off by a vernier from a large divided circle attached to the screw. The advantages arising from the peculiar construction of this micrometer are the following: 1. Distances can be observed with great accuracy up to about one degree, and the angles of position also. 2. The webs, being in the same plane, are free from parallax, and are both equally distinct, however high the magnifying power may be. 3. The webs are also free from distortion and from color. 4. A different magnifying power may be used on each of the objects; which may be advantageous in comparing a faint comet with a star.

DRAWING FROM RELIEF MODELS.

At the last meeting of the British Association, Captain Cybulz, of the Austrian army, called attention to a set of models intended to facilitate instruction in the manner of delineating the features of the ground on topographical maps, and lately introduced into the technical schools of Austria. It is the first aim of the author to lead the pupil, by means of these models, to a correct understanding or appreciation of *form*, as the only way of producing a first-rate topographical draftsman. Instead, therefore, of setting him to imitate drawings from paper, his studies and copies will be made from models, and, at a more advanced stage, from nature itself. These models represent, firstly, inclined planes or slopes, separate, in combination, or insecting each other. It is from these the pupil acquires the first idea of the principle upon which depends a correct delineation of the ground.

Secondly, we have three models, which represent the most characteristic and most widely distributed features of the ground. Having acquired from the preceding a thorough knowledge of fundamental principles, the pupil will proceed to delineate upon paper the following models. These represent, firstly, an undulating country; secondly, a plateau formation, with deeply-cut valleys; thirdly and fourthly, some mountainous tracts. Contour lines have been laid down upon the whole of these models with mathematical accuracy. The horizontal projection of some of the most difficult sections has also been added, to illustrate the manner of filling up the contour lines and laying down auxiliary contours. It has not, however, been thought advisable to do more, as otherwise the pupils would avail themselves of these facilities to too great an extent. A small instrument for measuring the gradients, and a scale showing the intensity of the shading (*hachorres*) for various degrees of acclivity, are to be made use of in copying the models. The author believes that the use of models, judiciously selected, will engage the pupil's uninterrupted attention; he will overcome mechanical difficulties with greater facility, and will not be so wearied as by the tedious, but abortive, and, in reality, useless attempts to copy a topographical drawing placed before him. The author would add, that his models are made of galvano-plastic copper, and are therefore not so liable to breakage as plaster-of-Paris models.

THE INDIA-RUBBER ARTIST.

We have all of us laughed at the grotesque appearance made by toy heads of vulcanized India-rubber. A little lateral pressure converts its physiognomy into a broad grin, whilst a perpendicular pull gives the countenance all the appearance that presents itself when we look into the bowl of a spoon held longways. The pressure removed, the face returns to its normal condition. Of the thousands of persons who have thus manipulated this plaything, it perhaps never struck one of them that in this perfect mobility lay the germ of a very useful invention, destined to be, we believe, of great practical value in the arts. If we take a piece of sheet vulcanized India-rubber and draw a face upon it, exactly the same result is obtained. This fact, it appears, struck an observant person, and out of his observation has sprung a patent process, worked by a company under the name of the "Electro Printing-Block Company," for enlarging and diminishing at pleasure, to any extent, all kinds of drawings and engravings. It must be evident that if a piece of this material can be enlarged equally in all directions, the different lines of the drawing that is made upon it in a quiescent condition must maintain the same relative distance between each other in its extended state, and be a mathematically correct amplification of the original draft. The material used is a sheet of vulcanized India-rubber, prepared with a surface to take lithographic ink; this is attached to a movable framework of steel, which expands by means of very fine screws. On this prepared surface lines are drawn at right angles; these are for the purposes of measurement only. The picture to be enlarged is now printed upon its face in the usual way; and supposing it is to be amplified four-fold, the screw framework is stretched until one of the squares formed by the intersection of the lines measures exactly four times the size it did while in a state of rest. It is now lifted on to a lithographic stone, and printed, and from the impression copies are worked off in the usual manner. If the picture has to be worked with type, the enlarged impression has of course to be made

from block plates, the printing lines of which stand up like those of a woodcut. This is accomplished by printing the picture, with prepared ink, upon a metal plate; the plate is then subjected to voltaic action, which eats away the metal, excepting those parts protected by the ink. Where it is required to make a reduced copy of a drawing, the process is inverted; that is, the vulcanized India-rubber sheet is stretched in the frame before the impression is made upon it. It must be evident that, on its being allowed to contract to its original size, it will bear a reduced picture upon its surface, from which the copies are printed.

The application of this art to map-work is very apparent. Let us instance the ordnance maps. Both enlargements and reductions of the original scale on which they were drawn have been made in the ordinary way at an enormous expense, the greater part of which might have been avoided had this process been known. As it is, we have gone to work in a most expensive manner. The survey for the whole of England was made on the very small scale of one inch to the mile for the country, and of six inches to the mile for towns, and now there is a cry for an enlarged scale of twenty-five inches to the mile. In other countries, comparatively speaking, poor to England, this scale has been far exceeded. For instance, even poverty-stricken Spain is mapped on the enormous scale of as many as sixty-three inches to the mile.

But with this question we have nothing to do; our purpose is only to show that it would be a great saving if the twenty-five inch scale had been originally carried out, as with this new process all the smaller scales could have been produced with perfect accuracy from this one at a very small cost.

Indeed, the public could, if they wish, have pocket fac-simile copies of that gigantic map of England and Scotland on the twenty-five inch scale, which, according to Sir M. Peto, would be larger than the London Docks, and would require the use of a ladder to examine even a county. The new art is applicable to engravings of every kind; and, moreover, it can very profitably reproduce type itself in an enlarged or reduced form. This is a fact of great importance to all Bible societies; for enormous sums are spent in producing this work in all imaginable sizes. But, it will be asked, what advantage does this method present over a resetting of the page in the usual manner? Two very important ones — speed and price. Let us suppose, for instance, that we wish to make a reduction of a royal octavo University Bible to a demy octavo. The price of resetting the type alone would be £800, and the "reading for corrections" another £300 at the least. Now, an identical copy could be produced by the process employed by the Company for £120; there would be no charge for "reading," as the copy is a fac-simile. Where there are many rules, marginal notes, and different kinds of types, as in Polyglott Bibles, the advantage of reproducing by the India-rubber process would be, of course, proportionately greater.

We may mention another power possessed by the new method, which will prove very valuable to publishers. It sometimes happens that when a new edition of a work is called for, some of the original blocks, or stereotyped impressions, are found to be wanting. Heretofore new drawings and engravings would have to be made; but now, all this difficulty is obviated by simply taking the engraved page out of the old book, and reproducing the block required from it. This actually occurred with respect to the well-known work "Bell on the Hand," the missing blocks of which have been

reproduced from some old printed pages. It is scarcely known yet how many centuries may elapse ere the ink of old books becomes so dry that it cannot be transferred by the new process; but it is quite certain that a couple of hundred years does not so far dry it as to render it incapable of giving an impression, so that we may have the earliest folio copies of Shakspeare's plays reproduced with exactness, in more available sizes, through the medium of a few sheets of India-rubber. —*Once-a-Week.*

COPYING-PAPER.

Copying-paper, into the body of which a certain proportion of protosulphate of iron (copperas) has been introduced, either during the manufacture or afterwards, by passing it between rollers covered with felt impregnated with a solution of salt, is much more advantageous in use than the common paper. A letter written with common ink containing an infusion of nutgalls, or having the tanno-gallate of iron for its base, and covered with the above copying-paper, gives, by means of the press, a perfect fac-simile. If a little sugar or pro-gallic acid is added to the ink, a good copy may be had by pressing lightly the copying-paper upon the latter without the use of the press, taking only the precaution to interpose between the hand and the sheet of copying-paper another sheet of oiled paper, over which the rubbing must be done. — *Cosmos.*

NEW METHOD OF PRINTING MUSIC.

A new method of engraving and printing music has been introduced at Paris. It is analogous to the method of carving wood by burning the pattern in. The music is stamped into blocks of wood with heated stamps, which have a shoulder to insure their penetrating to an equal depth. From this block a stereotype cast is taken. An edition of fifteen hundred copies, if stereotyped and printed by this method, is said to cost only about one-third as much as if engraved and printed from the engraved plate.

S. W. FRANCIS' WRITING-MACHINE.

This machine is placed in a neat, portable writing-case, about two feet square and ten inches deep, which may be carried about and used on any ordinary table. It is worked by means of keys placed on a key-board like those of a piano, each key representing a letter of the alphabet, and each letter producing its impression at a common centre. An endless narrow tape stretches the full length of the "bed" of the machine, passing over a small roller at either end, and uniting underneath. This tape is saturated with the ink.

Directly in the centre of the "bed," and under the tape, is a circular hole of one inch diameter. Over this hole, and under the tape, on a car, a sheet of paper is placed; then a sheet of tissue paper directly over it, leaving the tape between the two sheets of paper. A delicate frame then falls upon the paper, which keeps it in place, and moves while the printing progresses.

A short steel rod then falls from a suspended arm, so as to present a flat surface, or platin, in the centre, directly over the paper. The lids being raised from the keys, they are played upon as in a piano, each being lettered from A to Z, with the various punctuation marks, etc. The numbers

are represented by letters, as CVIII. for one hundred and eight, and so on, and the capitals are designated by a single dash at the top of the requisite letter.

Each key, when struck, acts upon an independent lever within the machine, attached to a little elbow and arm, on the end of which is the corresponding letter-type, which now strikes the under sheet of paper and presses against the platin on the suspended steel rod, so that, the inked tape being between the two sheets of paper, the blow leaves the letter printed on each, namely, on the upper side of the lower sheet, and, of course, on the lower side of the upper, when brought in contact with the tape.

As the printing goes on, the paper moves steadily to the left; and when the line is within four letters of its end, a little bell rings spontaneously to notify the writer that he must touch a spring which pushes the sheet up the space of one line, and back, to begin again; and as the printing of the new line goes on, the paper travels back another line; and so on, till the page is completed.

The letters can be formed of any sized type, engraved for the purpose, and suiting the taste of the purchaser. Those who use this "Writing Printer" will be enabled to strike off two copies in less time than is required to produce one with the pen; and for clergymen, merchants, editors, and literary men, it must prove of great value. The price of the machine is one hundred dollars, which is as cheap as a good sewing-machine, while the art of working it is not more difficult. The inventor is S. W. Francis, of New York City.

ON THE INFLUENCE OF SCIENCE ON THE ART OF CALICO PRINTING.

The following lectures on the progress of calico printing are communicated to the London *Engineer* by Prof. F. Crace Calvert, F. R. S.

Pencilling and Block Printing. — During the early part of this century, the production of designs upon calico were performed by means of hand-blocks, made of sycamore or pear-tree wood. The face of the block was either carved in relief into the desired pattern, like ordinary wood-cuts, or the figure was formed by the insertion, edgewise into the wood, of narrow strips of flattened copper wire, and the patterns were finished by the hand labor of women, with small brushes called pencillings. Owing to a strike, amongst the block printers, in 1815, to resist the threatened introduction of machinery, great efforts were made on the part of the employers to render themselves independent of hand labor; and the result has been the gradual introduction of cylinder printing.

Engraving. — The first kind of roller used was made by bending a sheet of copper into a cylinder, soldering the joint with silver; and then engraving upon the continuous surface thus obtained.

The second improvement consisted in producing the pattern on copper cylinders obtained by casting, boring, drawing, and hammering. In this case, the pattern is first engraved in intaglio upon a roller of softened steel of the necessary dimensions. This roller is then hardened, and introduced into a press of peculiar construction, where, by rotary pressure, it transfers its design to a similar roller in the soft state, and the die being in intaglio, the latter, called the "mill," is in relief. This is hardened in its turn, and, by proper machinery, is made to convey its pattern to the full-sized copper roller. This improvement alone reduced the cost of engraving on copper

rollers many hundred per cent., and, what is of far greater importance, made practicable an infinite number of intricate engravings which could never have been produced by hand labor applied directly to the roller.

A further improvement was made by tracing with a diamond on the copper roller, covered with varnish, the most complicated patterns, by means of eccentrics, and then etching.

The combination of mill engraving with the tracing and etching processes naturally followed, adding immensely to the resources of the engraver and printer in the production of novel designs.

Another development of this art is the tracing of patterns on the surface of rollers, which has been effected by machines constructed on the principle of the pentagraph. Although this invention dates from 1834, still it is only of late years that it has been successfully applied.

But if mechanical art has greatly assisted the engraver, chemistry has rendered him equally important services, by enabling him to abandon costly and cumbrous modes of impressing by force the designs on the cylinder, substituting for them a great number of etching processes. By some of these processes, as by every other addition to the resources of the engraver, an entirely new and beautiful class of engraving is produced, unattainable by any other known means.

A very recent improvement is highly interesting in a scientific point of view. It is the application of galvanism to the diamond tracer. By combining the galvanic action with the eccentric motion, most beautiful and delicate engravings can be produced. This is effected by tracing the pattern with a varnish on a zinc cylinder, which is so placed in the engraving machine that, as a needle passes over its surface, and comes in contact with the zinc, the galvanic current is established, and, by simple machinery, causes the diamond to trace the corresponding pattern on the copper roller. The communication is so rapid and so precise, that this invention of Mr. Gaiffe, of Paris, bids fair to produce very important results. Galvanism is also made use of for producing effects on roller surfaces by depositing copper thereon.

To give an idea of the extraordinary influence which the introduction of machinery and improvements in engraving have had in cheapening the cost of printed calicoes, I may state that large furniture patterns, such as are required for Turkish, Egyptian, and Persian markets, into which sixteen colors and shades enter, would have cost formerly from thirty to thirty-five shillings per piece, because they would have required sixteen distinct applications of as many different blocks, and would have occupied more than a week in printing, where the same piece can now be printed in one single operation, which takes three minutes, and costs five or six shillings. So rapid is the progress of one branch of manufacture in connection with another, that it has only recently been possible to produce the rollers capable of performing this operation, that is to say, cylinders of copper forty-three inches in circumference by forty-four inches long. For light styles of printing, the time required to print a piece of thirty-six yards is not more than one minute.

Chemistry. — But the discovery which has exercised more influence than any other on the progress of calico printing is the application of chlorine gas as a bleaching agent. Previously to the employment of this gas (chiefly as bleaching powder), the imperfect bleaching of a piece of calico required six weeks; and as it had to be exposed to the action of the atmosphere, a

large surface of land was required. Further, at that time, bleachers had to use potashes imported from Canada; whereas, at the present time, thanks to the progress of chemical knowledge, not only is soda-ash manufactured in this country, but, by the application of bleaching powder, calicoes are much better bleached in twenty-four hours than they were formerly by a six weeks' exposure to the atmosphere; and even when an extra cleaning and whiteness are required, as for madder goods, only two days are necessary. The aid of machinery renders possible the continuous process, that is to say, several hundred pieces of gray calico are sewn together, end to end, and made to pass from one operation to another, without any pause, until they are bleached. So rapid and economical is this method that the cost of bleaching a piece of calico does not exceed one or two pence. Chlorine, again, renders a great service to the calico printer, by enabling him, after his madder goods have been produced and soaped, to obtain fine whites without the necessity of exposing them for several days in the meadows to the action of the atmosphere. In fact, the discovery of garancine and alizarine, and their application to calico printing, have facilitated the production of madder styles at very low cost, as the whites of such goods require no soaping, and only a little bleaching or cleaning powder.

Cotton has this peculiarity, as distinguished from wool and silk, that it will not fix any organic color, excepting indigo, without the interposition of a mordant, which is generally a metallic oxide or salt. The two most important discoveries in connection with this necessity of calico printing were, first, that made in 1820, by Mr. George Wood, of Bankbridge, who found out the means of preparing calicoes with peroxide of tin, which enabled printers to produce a large variety of prints called steam goods; and, secondly, that of Walter Crum, Esq., F. R. S., who, in a paper presented to the British Association, at Aberdeen, in 1859, showed that the tedious process of ageing madder mordants for three or four days might be dispensed with by passing the goods, during a quarter of an hour, through a moist atmosphere, at a temperature of 80° to 100°, where the mordants absorb the required quantity of moisture, and then rapidly undergo the chemical changes necessary to fit them for producing the black, purple, lilac, red, pink, and chocolate colors, which the madder root will yield immediately in the dyebeck, according to the nature of the mordant previously fixed in the cloth.

As it is impossible in the brief space of an hour to convey an idea how various colors are produced on prints, I shall confine my remarks to illustrating the interesting fact that abstruse science has brought to light various substances which have lately proved valuable accessories to the resources of the calico printer. Thus Dr. Prout, some thirty or forty years ago, made the curious discovery that uric acid possessed the property of giving a beautiful red color, when heated with nitric acid, and then brought into contact with ammonia. The substance thus obtained was further examined by Messrs. Liebig and Wöhler, in a series of researches which have been considered as amongst the most important ever made in organic chemistry; and this substance they call murexide. In the course of these investigations they also discovered a white crystalline substance, called alloxan. For twenty years both these substances were only to be found in the laboratory; but in 1851, Dr. Saac observed that alloxan, when in contact with the hand, tinged it red. This led him to infer that alloxan might be employed to dye woollens red; and further experiments convinced him that if woollen cloths were prepared with peroxide of tin, passed through a solution of alloxan, and then sub-

mitted to a gentle heat, a most beautiful and delicate pink color resulted. Subsequently, murexide was employed and applied successfully by Mr. Depouilly, of Paris, to dyeing wool and silk, and to printing calicoes, by the aid of oxide of lead and chloride of mercury as mordants; but the great obstacle to its extensive use was the difficulty of obtaining uric acid in sufficient quantity for its manufacture. The idea soon occurred to chemists to extract it from guano; and this is the curious source whence the chief supply of uric acid is obtained, and which enables Edmund Potter, Esq., and other printers, to produce the color called Tyrian purple.

Another example will be found in the successive scientific discoveries which have led to the discovery of the recently popular color, mauve. Lichens, which have been the subject of extensive researches on the part of Robiquet, Heeren, Sir Robert Kane, Dr. Schunck, and especially of Dr. Stenhouse, have yielded to those chemists several new and colorless organic substances, which, under the influence of air and ammonia, give rise to most brilliant colors, and amongst these are orchil and litmus. Dr. Stenhouse, in a most elaborate paper published by the Royal Society in 1848, pointed out two important facts: first, that the color-giving acids could be easily extracted from the weed by macerating it in lime-water, from which the coloring matters were easily separated by means of an acid; and, secondly, the properties of certain coloring acids, which gave M. Marnas, of Lyons, the key which enabled him to produce commercially from lichens a fast mauve and purple, which, up to 1857, had been considered impossible of attainment.

The commercial production by Mr. W. H. Perkin of another purple at the same time is not less interesting. Some thirty or forty years ago, Dr. Runge obtained from coal-tar six substances, amongst which was one called kyanol, which substance was thoroughly examined by Dr. Hoffman, who proved it to be an organic alkaloid, and identical with a substance known as aniline. Owing to the subsequent study of this substance by this chemist, and the discovery that it yielded a beautiful purple color when placed in contact with bleaching powder, his pupil, Mr. Perkin, was induced to make experiments with a view of producing commercially a fast purple, in which he succeeded. The process devised by this chemist is exceedingly simple, and consists in oxidizing aniline by means of bi-chromate of potash and sulphuric acid.

More recently, M. Renard found a method of producing also from aniline, by means of chlorine compounds, a most splendid rose color, called by him *fuchsiachine;* and within a few months Mr. Price has also succeeded in producing from aniline, by the employment of peroxide of lead, either a fast purple, or a pink, called by him *roseine,* and a fast blue, according to the mode of operating. All these colors require special mordants to fix them on calicoes or muslins, such as albumen, lactarine, and other azotized principles.

In concluding, I cannot give a better idea of the immense magnitude of the calico-printing trade of Great Britain, than by quoting the number of yards exported, which amounted in 1858 to nearly eight hundred millions.

MINIATURE AND ENAMEL PAINTING.

Painting in miniature is in danger of becoming one of the lost arts. Photography has been carried to such a degree of perfection, is so accurate as to mere likeness, and is, withal, afforded so cheaply, that it is rapidly taking the place of portraits upon ivory. Artists who have hitherto devoted themselves to this branch of the art are now either turning their attention to

painting upon canvass, or find employment as finishers of the photographic miniatures. To this, indeed, is owing, in a large measure, the satisfaction which the photographs give, for something of the value of the old miniature in colors is retained where the work is skilfully done, and the inevitable faults of the instrument are, in some degree, corrected. The following historical sketch of the art, which seems thus to be going out, and of enamel painting, which photography is also in some degree supplanting, is instructive and entertaining.

Miniature painting, since the invention of printing superseded the art of the calligrapher and illuminator, has been confined principally to portraiture, and the ancient vellum has been discarded for ivory and enamel. Ivory is preferred for the soft semi-transparency of its texture, which communicates a peculiar delicacy to the colors, especially the carnations or flesh tints. The ivory being cut in thin sheets, requires however, on account of this property, something perfectly white and not liable to tarnish, at the back, to serve as a foil; otherwise the effect of the painting might be quite destroyed by the darkness of the surface behind showing through. Ivory and enamel being quite smooth, and without texture or absorbency, it is impossible to spread a flat tint. With the most dextrous handling, a little heap of color will collect where the brush first touches or leaves the surface, and the intervening space, which it may have been intended to cover with an even "wash," will present something of the irregularity of a flow of water on a greasy plate or polished table. Hence it becomes necessary to fill up the interstices of these irregularities with hatchings and stipplings. The point and steel scraper are both used, to more rapidly procure the desired gradation, as well as to obtain mechanical regularity in the stippling, which has been much sought for, particularly by French artists. It is true that the labor thus involved may be avoided in certain parts by the use of body-colors — that is to say, colors rendered opaque by the addition of white. But body-color washes, from their unmanageable nature on ivory, can only be used in portions which can be covered at once, or do not require much finish, such as backgrounds and draperies; and here the surface of the ivory is of course sacrificed. Body-color applied in this way will give an even, flat gradation in a background, and impart a cloth-like effect to the representation of the modern male costume; but from the difficulty of calculating when "wet" the difference of tone the body-color will assume when dry, it is useless for flesh painting, if spread in coats so as to cover the ivory. Opaque and semi-opaque pigments, of earthy and mineral extraction, were, we know, used in the flesh by the ancient painters on vellum; but then they were lightly stippled, not loaded; and such pigments may be worked transparently in the same way on ivory, though the modern miniature painters prefer the more transparent colors. Where body-color, therefore, is laid on in certain parts, so as to cover the surface, and the ivory shows through in other portions, the work can scarcely be harmonious. For this reason the use of body-colors, which were extensively and are still employed by French miniature painters, has been discontinued by the English artists of the present century. Gum-water is the only vehicle besides simple water employed with the transparent or body colors.

The large size of modern miniatures may excite some curiosity as to how a sheet of ivory can be obtained so much larger than the diameter of the largest elephant's tusk, especially when it is known that the sheet is not joined, as might be supposed. The tusk is simply sawn circularly — in other

words, round its circumference; the ivory is then steamed, and flattened under hydraulic pressure, and finally mounted with caoutchouc on a mahogany panel.

Enamel painting has the great recommendation of being perfectly indestructible. Specimens of this art applied to pottery are now in existence which have not changed their hues during three thousand years. The enamel tints on Egyptian idols, scarabei, necklaces, etc., are precisely similar to the colors now produced by the enameller. The difficulty of handling the brush is quite as great as in painting on ivory. But a far greater technical difficulty is that of calculating the exact effect of the process of firing the enamel, in altering the hues of the several applications of color. Fine coloring is therefore rarely found in enamels. Moreover, the enamel painter's list of pigments is limited to those prepared from metallic oxides, and many metals are perfectly useless on account of the high degree of heat to which enamel paintings are subjected. Modern science has, however, done much to supply this deficiency. The colors are mixed with oil of spike or lavender, or with spirits of turpentine. These essential oils volatilize rapidly under the effect of heat, but the fixed oils would cause the enamel to blister. The ordinary brushes of the painter in water colors are used.

We extract the following valuable remarks on enamel painting, and account of the process employed by the artists of the present day, from a communication to the *Art Journal*, in 1859, by an enamel painter of reputation. He says: "Pictures in enamel of any importance as works of art have been very rarely produced until within the last eighty or ninety years; for, although Petitot, in the reign of Louis XIV., drew with exquisite neatness, he seldom produced enamels which aimed at more than microscopic finish and accurate drawing of the human head. His works generally measure from about an inch and a half to two inches in diameter, and are usually either circular or oval. It was reserved for modern times to try a bolder flight, and the result has been that enamel paintings are now produced with every possible excellence in art. The rich depth of Rembrandt and Reynolds can be perfectly rendered, together with all their peculiarities of handling and texture; and the delicacy of the most beautiful miniature of ivory may be successfully competed with. As regards size, enamels are now painted measuring as much as sixteen inches by eighteen, and fifteen inches by twenty. The kind of enamel used for pictorial purposes is called 'Venetian white hard enamel;' it is composed of silica, borax, and oxide of tin. The following is a brief description of procedure in the art of enameling:

"To make a plate for the artist to paint upon: A piece of gold or copper (usually gilt) being chosen, of the requisite dimensions, and varying from about an eighteenth to a sixteenth of an inch in thickness, is covered with pulverized enamel, and passed through the fire until it becomes of a bright white-heat; another coat of enamel is then added, and the plate again fired; afterwards a thin layer of substance called *flux* is laid upon the surface of the enamel, and the plate undergoes the action of heat for the third time. It is now ready for the painter to commence his picture upon. 'Flux' partakes of the nature of glass and enamel: it is semi-transparent, and liquefies more easily in the furnace than enamel. When flux is spread over a plate, it imparts to it a brilliant surface, and renders it capable of receiving the colors; every color, during its manufacture, is mixed with a small

quantity of flux; thus, when the picture is fired, the flux of the plate unites with the flux of the color, and the coloring pigment is perfectly excluded from the air by being surrounded by a dense vitrified mass. From this will be understood the indelible — and we might almost say eternal — nature of enamel.

"The plate undergoes the process of firing after each layer of color is spread over the whole surface. This process corresponds to the drying of the pigments in oil or water-color painting before the artist ventures to retouch his work. Sometimes highly-finished enamel requires fifteen or twenty firings. Great care must be taken to paint without errors of any kind, as the colors cannot be painted out or taken off, as in water or oil, after they have once been vitrified, without incurring excessive trouble and loss of time. If the unfortunate artist miscalculates the effect of the fire on his pigments, his only alternative is to grind out the tainted spot with pounded flint and an agate muller; and so hard is the surface, that a square inch will probably take him a whole day to accomplish."

THE IVORY TRADE.

The principal source of supply of ivory is Africa — much of it coming from the interior by way of Egypt and the Nile. Until within a few years the Egyptian pashas made trading up and down the Nile a monopoly; now, Egyptian, French, German, and English merchants explore the remote resources of the river, not for the purposes of science, but for those of commerce. In the last report of sales of ivory in London, the head-quarters of this traffic, we find that eighty-five thousand pounds of the ivory sold was "Egyptian;" that is, found its way to civilization through Egypt.

That Africa was the source whence the ancients of southern Europe drew their supply, we learn from Pliny the Younger, who says that the vast consumption of ivory for articles of luxury compelled the Romans to seek for it in another hemisphere, "as Africa had ceased to furnish elephants' tusks except of the smallest kind."

After the overthrow of the Roman Empire, the commerce between Europe and Africa was suspended for centuries. At length the enterprise of Portugal, the eldest daughter — the Lusitania — of Rome, opened anew Africa and India. In the meantime, the lordly elephant had multiplied in his native forests, and if the long tusks were secured by the natives, they served merely the plebeian purposes of door-posts, or the defences of wooden idols. Battell, a quaint old Englishman, who served in the early Portuguese armies, says that the Africans "had their idols of wood, fashioned like a negro, and at the feet thereof was a great heap of elephants' teeth, containing three or four tons of them." It is a well-known fact that the inhabitants of Angola and Congo, when the Portuguese first occupied those coasts, were found to have preserved an immense number of elephants' teeth, the accumulation of centuries. For a long time this ivory was exported in vessels of Portugal to various parts of Europe; and this traffic formed one of the most lucrative branches of the early modern trade with Africa. About the middle of the seventeenth century this store became exhausted, and the sons of Ethiopia were instigated to imitate their ancestors in renewing the battle with the wide-eared, long-tusked *Elephas Africanus*.

To-day, the amount of ivory consumed in the workshops of Europe, America, and India, is immense; and yet, great as it is, the continent of

Africa furnishes seven-eighths of all that is worked up into ornaments, toys, and crucifixes in France; heathen gods, boxes, and fans in India and China; billiard-balls, boxes, miniature plates, chessmen, mathematical rules, keys for piano-fortes, organs and melodeons, fans, combs, folders, dominoes, and a thousand and one other things, in England, Germany, and the United States.

Portugal was the England of the sixteenth century in more respects than one. For two centuries Portugal held, in the East and on the African coast, the power and influence now in the hands of England. Lisbon at that time was the head of the ivory market; now London is the mart where ivory-dealers most do congregate. It sometimes occurs that the Salem and other American merchants engaged in the African trade ship their tusks — or teeth, in commercial parlance — to London after they have brought them from the Zanzibar and Mozambique coast to the United States. In the world's great metropolis there occurs at regular intervals one of those sales which furnish the manufactures with their stock of elephants' teeth.

While we associate ivory and India together, but very little of the former comes from the latter. It is estimated that to supply ivory to the British market for the last few years, it has required about 1,000,000 lbs. annually. Of this quantity, Ceylon, the great elephant park of India, furnishes only 500 or 600 tusks. The ivory which is put down in the printed reports of sales as "Bombay," in nine cases out of ten is shipped by Mohammedan merchants from the east coast of Africa to the large north-western commercial emporium of Bombay. We do not mean, however, to assert that no elephants' tusks come from Asia; for occasionally there will be small lots come from Ceylon and Sumatra. There is also a large ivory trade between Zanzibar and China, *via* Bombay. A great deal of ivory, we may state, by the way, now reaches the United States directly from Africa.

The immense demand for elephants' teeth has of late years increased the supply from all parts of Africa. At the end of the last century the annual average importation into England was only 192,500 lbs.; in 1827 it reached 364,784 lbs., or 6,080 tusks, which would require the death of at least 3,040 male elephants. It is probable that the slaughter is much greater, for the teeth of the female elephant are very small; and Burchell tells us, in his African travels, that he met with some elephant-hunters who had shot twelve huge fellows, which, however, altogether produced no more than 200 lbs. of ivory. To produce 1,000,000 lbs. of ivory, the present annual English import, we should require — estimating each tusk at 60 lbs. — the life of 8,333 male elephants. It is said that 4,000 tuskers suffer death every year to supply the United States with combs, knife-handles, billiard-balls, etc. etc.

A tusk weighing 70 lbs. and upwards is considered by dealers as first-class. Cuvier formed a table of the most remarkble tusks of which any account has been given. The largest on record was one which was sold at Amsterdam, which weighed 350 lbs. In the late sales at London, the largest of the "Bombay and Zanzibar" was 122 lbs.; of "Angola and Lisbon," 69 lbs.; of "Cape of Good Hope and Natal," 106 lbs.; of "Cape Coast Castle, Lagos," etc., 114 lbs.; of "Gaboon," 91 lbs.; "Egyptian," 114 lbs. But it must not be inferred from this that large tusks are now rare. On the contrary, it is probable that more long and heavy teeth are now brought to market than in any previous century.

A short time ago Julius Pratt & Co. cut up, at their establishment in Meriden, Ct., a tusk that was nine and a half feet long, eight inches in diameter,

and which weighed nearly two hundred pounds. The same firm, in 1851, sent to the World's Fair, London, the widest, finest, and largest piece of ivory ever sawed out. By machinery, invented in their own factory, they sawed out (and the process of sawing did the work of polishing at the same time) a strip of ivory forty-one feet long and twelve inches wide. It took the precedence of all the specimens sent in by England, France, or Germany, and received rewarding attention from the Commissioners.

The most costly tusks, or portions of the tusks, are those which are used for billiard-balls. What are termed "cut-points" of just the right size for billiard-balls, from 2¼ to 2¾ inches in diameter, brought the highest price (£25) per cut of any ivory offered in the London market at the late sales. Billiard-ball making has of late become a very important item of manufacture in this country.

The teeth from the west coast, with the exception of "Gaboon," are less elastic and less capable of bleaching than those that come from other portions of Africa. The west coast tusks are much used for knife-handles. Since the French have possessed Algeria, France receives a considerable portion of ivory from Central Africa by the large caravans that travel from Timbuctoo northward.

Ivory is also furnished by the walrus, or sea-horse, and commands a price equal to the best qualities of elephant ivory. It is, however, too hard and non-elastic for many purposes, and has the disadvantage of being too small to cut up profitably.

NON-INFLAMMABLE FABRICS.

In the long list of casualties that we are frequently called upon to read, appear too often the accounts of women and children burned to death by the ignition of their clothing. The frequency of these accidents is startling and painful, not only here, but in those countries where the same style and material in dress prevails. As these causes generally occur in consequence of an immediate contact with the burning coals of a grate or stove, it seems but just to conclude that the present mode of wearing extended skirts renders the risk much greater, and increases the danger of a fatal sacrifice to fashion. Some of the garments of women are extremely inflammable, and these are worn so near to the person that it becomes next to impossible, in case of their ignition, to divest the wearer of them until she is seriously injured. This is particularly the case with the lighter materials of which party and evening dresses are composed; and this fact should impress itself upon the public mind here, as it has in England, where the Queen, a short time since, requested the Master of the Mint, Professor Graham, to superintend a series of experiments with a view to determine if these fabrics could by easy means be rendered non-inflammable. The professor entrusted the inquiry to two distinguished chemists, Dr. Oppenheim and Mr. Versmann.

From an article on the subject, contributed by Robert Hunt to the London *Art Journal*, we learn the prominent points of their report. They commence by stating some of the peculiarities of cotton and linen, and then enumerate the numerous articles which have been from time to time employed and recommended by different parties to render them flame-proof, such as alum, borax, silicate and carbonate of potash, sulphate of iron, sulphate of lime, the chloride of ammonium, and other salts of ammonia; but state that none of these experiments resulted satisfactorily.

Experimenting upon the sulphate of ammonia, as recommended by Guy-Lussac, they further state that a solution containing seven per cent. of the crystals, or sixty-two per cent. of anhydrous salt, is perfectly anti-flammable, and add: "Tungstate of soda ranges among the salts which can be manufactured on a large scale, at a cheap rate. A solution containing twenty per cent. renders the muslin perfectly non-inflammable. It acts, apparently, by firmly enveloping the fibre, and thereby excluding the contact with the air. It is very smooth, and of a fatty appearance, like talc, and this property facilitates the ironing process, which all other salts resist." And again: "For all laundry purposes the tungstate of soda can only be recommended."

The following formula is given as having proved efficacious, and will simplify the application: "A concentrated neutral solution of tungstate of soda is diluted with water to twenty-eight degrees Twaddle, — an alkaliometer so called, — and then mixed with three per cent. of phosphate of soda. This solution was found to keep and to answer well. It has been introduced into her Majesty's laundry, where it is constantly used."

The solution can be applied to any fabric. It is only necessary to dip the cleansed article in the prepared fluid, and then drain and dry it, after which it may be ironed; or, if preferred, the solution may be incorporated with the starch to be used in the stiffening. Although the above are not the only experiments that have been tried in Europe, yet they are, perhaps, the most successful, and the result should be accepted, and the advice followed, wherever these fabrics are used. The lightest materials, when submitted to this preparation, may char and shrivel, but they will not blaze. As the usual solicitude and warnings will not avert the fatal consequences, it would seem that the only method of saving life from ignition of clothing consists in wearing those articles only which have been steeped in this life-saving fluid.

INTERESTING FACTS IN REGARD TO THE VALUE OF SEWING-MACHINES.

In the recent contest before the Commissioner of Patents for the extension of Howe's patent for sewing-machines, the following facts were proved in relation to the value of the patent, which, at first thought, are certainly astonishing.

Ezra Baker states that the amount of the boot and shoe business of Massachusetts is $55,000,000 annually, and the ladies' and misses' gaiter boot and shoe business is at least one-half of the whole boot and shoe business in that state; and is, therefore, equal to $27,500,000. He also states that about one-eleventh of these $55,000,000 is paid for sewing labor. From this proportion it appears that the annual sewing labor upon ladies' and misses' gaiter boots and shoes is $2,500,000, and that it would cost four times as much if done by hand; so that the annual saving by this invention in the manufacture of ladies' and misses' boots and shoes in one state is $7,590,000. The price of these shoes has been reduced to the consumer one-half by the introduction of sewing-machines — the price of material remaining the same.

Oliver F. Winchester is a manufacturer of shirts at New Haven, Conn. He says that his factory turns out about eight hundred dozen per week; that he uses four hundred sewing-machines, and that a machine, with an attendant, will do the work of five hand-sewers at least, and do it better.

He pays, at least, $4 per week; but, reckoning it at $3,—the old price for sewing before machines were introduced,—it shows a saving, in this single manufactory, of $240,000 a year. Allowing the males of the United States to wear out two shirts a year apiece, and a proportional saving would amount to $11,680,000 annually in making the single article of shirts.

James W. Millar, connected with Brooks Brothers, of New York City, manufacturers of clothing, states that that house alone does a business of over $1,000,000 annually, and use twenty sewing-machines in the store, and patronize those that others use, and do about three-fourths of all their sewing by machines, and pay annually for sewing labor about $200,000; $75,000 of this is saved by machines; that is, the machines save $75,000 on every $200,000 paid for sewing labor. And he states that the house of Brooks Brothers does not make one-hundredth part of the machine-made clothing manufactured in New York. This, putting the proportion at one-hundredth part, would make the business of manufacturing machine clothing in the city of New York $100,000,000 annually; and, at the rate that house pays for sewing, it brings the cost of sewing in this branch of manufacture in the city of New York—even with the assistance of the sewing-machines—up to $20,000,000. A saving of $75,000 on every $200,000 of this makes $7,500,000. James McCall states an estimate of what proportion of the clothing business of the United States is done in the city of New York, and puts it at about one-tenth. Multiplying the cost of sewing in that business alone in New York, as shown above, by ten, it carries the extent of cost in the United States to $200,000,000 per annum; and assuming that as large a portion of this is done by machines in other places as is done in the city of New York, it makes the cost of sewing labor in this particular manufacture in the United States the above sum of $200,000,000; and this, too, by the assistance of machine sewing. $75,000 on every $200,000 of this is saving, which makes the saving in the United States amount to $75,000,000 annually in this branch alone.—*Scientific American.*

MAGIC RUFFLES.

Ruffles have been worn from time immemorial; but "Magic Ruffles," or ruffles made by magic, are a modern invention. The old lady in her frilled cap, two generations ago, could hardly have believed that her granddaughter would, by the assistance of mechanism and steam, be enabled to make ruffles at the rate of two yards a minute, and of more perfect workmanship than it is possible to produce by hand.

Two inventors, of New York city, have recently devised an attachment to the sewing-machine, for the manufacture of ruffles, which bids fair to prove more valuable than any other of the four hundred patented improvements on the original invention.

Through the combined genius of these hundreds of patentees, the sewing-machine had gradually approached perfection, until the variety of work to which it was adapted had nearly equalled that of the needle and thimble of the seamstress. Stitching, hemming, and cording were done with great rapidity, and even gathering was considerably expedited by its use; but in making ruffles, puffs, and many other kinds of gathered fabrics, the ordinary process, even with a sewing-machine, is a slow and tedious one, requiring much manipulation and great care. This last invention, however, renders the process as simple and rapid as plain sewing. It has not yet been applied

to family machines, but has been used by the proprietors for several months past in the manufacture of a new kind of ruffles for the market, which are applied to a great variety of uses.

Except in its perfection and the uniformity of its gathers, the Magic Ruffle very nearly resembles the old article worn by our grandmothers; but on close inspection it is found to contain no gathering-thread, the gathers being confined by the same line of machine-stitching that holds it to the strip of cloth to which it is attached.

The patent for this machine was granted in May, 1860, since which time the manufacturing of the new ruffles has developed into a gigantic business; one company in New York turning out from ten to fifteen thousand yards of ruffling daily, while the orders for the goods are constantly in advance of the production. — New York *Tribune*.

PRINTING FABRICS IN IMITATION OF EMBROIDERY.

M. Perrot, France, has recently discovered a novel mode of ornamenting fabrics, by the printing process, so as to produce an effect similar to embroidery. This process consists simply in printing, by the aid of rollers, any desired pattern upon a fabric, in a solution of gutta-percha, previously bleached by the aid of chlorine, and dissolved by any of the well-known solvents. The fabric so printed is then passed through a box or casing containing woollen, cotton, silk, or other fine flock or colored powder, which adheres only to those parts impressed with the solution, and forms beautifully raised patterns and devices, having a fine, soft, and velvety surface.

CHINESE EMBROIDERY.

Probably the finest modern examples of pure embroidery in silk, unmixed with gold and silver thread, pearls, or precious stones, are executed by the Chinese. Not only in execution, but in design and the fitness of the forms of the ornament to the material and purpose, the embroideries of the Chinese generally exhibit a great superiority to the usual examples of European skill. The extreme care taken with the work, especially in the more costly specimens, renders them very instructive examples of textile decoration. From seven hundred to seven hundred and fifty stitches may be counted in the space of a square inch. Some years ago I took the trouble to dissect some of the best examples I could meet with, and the more closely they were examined the more marvellous the work appeared. — *Mr. Wallis, Journal of Society of Arts, London.*

NEW METHOD OF EMBOSSING WOOD.

At a recent meeting of the Franklin Institute, Mr. Wood exhibited some specimens of wood embossed by his patent process. The wood is soaked in water, and then subjected to pressure under a metal matrix heated sufficiently to burn away the superfluous material. The wood is not finished at one operation, the matrix being removed several times in order to brush off the charred wood. The specimens possess more softness than is usual in wood carvings; and when varnished have a beautiful appearance. The design is first modelled in clay or wax, and a plaster cast taken from it; this serves as a pattern from which the matrix is moulded. The saturation

by water prevents the burning or charring of the material not immediately in contact with the metal.

ARTIFICIAL WOOD.

In a recent lecture at the Conservatoire des Arts et Metiers, M. Payen called the attention of his hearers to the process of making a kind of ebony, or artificial wood, very hard, very heavy, and capable of receiving a very high polish and a brilliant varnish. M. Ladry, the inventor of this process, takes very fine sawdust, mixes it with blood from the slaughter-houses, and submits the resulting paste to a very heavy pressure obtained by the hydraulic press. If the paste has been enclosed in moulds it will take the form of the mould, and resembles pieces of ebony carved by a skilful hand.

Another curious application of this paste consists in the formation of brushes. The bristles are arranged in the paste while yet soft; the paste is covered by a plate pierced with holes, through which the bristles pass; the pressure is then applied, and brushes are obtained, made of a single piece, cheaper and more lasting than the usual kind. This artificial wood of M. Ladry is much heavier than common woods. — *Cosmos.*

WHY THE SHOE PINCHES.

A pamphlet has lately appeared of peculiar interest to that vast multitude of our population who are the victims either of corns or of expensive corn doctors, and who suffer, as some poet has suggested, from a style of *bunion* which is not altogether conducive to "Pilgrims' Progress." It is translated from the German by a young Edinburgh physician, and published with the following title: "Why the Shoe Pinches; a Contribution to Applied Anatomy. By Hermann Meyer, M. D., Professor of Anatomy in the University of Zurich. Translated from the German by John Stirling Craig. Edinburgh: Edmonston and Douglas."

Dr. Meyer, the author, is pronounced one of the highest continental authorities on Physiological Anatomy, who has published an important general text on that science, as well as several treatises on the structure of the foot and knee. In the discussion now under consideration he has already been preceded by Peter Camper, who, in the last century, wrote a paper "On the Best Shoe," and who zealously but ineffectually urged that the foot-gear of man was quite as important a topic as the shoeing of horses, to which so much attention is given.

Against the prevailing pattern, Dr. Meyer, in his capacity of anatomist, utters an earnest protest. The cut of a shoe, says the Doctor, is not, as the cut of a coat, a matter of indifference. "When Fashion prescribes an arbitrary form of shoe, she goes," he asserts, "far beyond her province, and, in reality, arrogates to herself the right of determining the shape of the foot."

In his opinion the shoemaker ought not only to produce a shoe that does not pinch, but a shoe so constructed that it will give to a foot distorted by the pinching it has borne already, a fair chance of a return to its right shape, and full possession of its power as a means of carrying the body onward. He tells us that, in measuring a foot for a shoe or boot, the first thing to be considered is the place of the great toe. Upon this toe, in walking, the weight of the whole body turns at every step; in the natural foot, therefore,

it is in a straight line with the heel. A central straight line drawn from the point of the great toe to the middle of its root, if continued, would pass very exactly to the middle of the heel. By the misfitting boot commonly worn, the point of the toe is pressed inwards, the root outwards.

The practice adopted by many of having a last made of the exact size and model of the foot, is condemned by Dr. Meyer, if the foot has been previously injured in consequence of wearing ill-fitting boots or shoes. If a cast be made of a distorted foot, and a boot fitted to that, it is bad, because thereby the distortion is confirmed. It would be much the better, therefore, says the Doctor, so to form the boot that the conditions of healthy walking are allowed for, and the bones, at least to some extent, can gradually right themselves. To a foot shortened by distortion he would fit a shoe adapted to its healthy size. But of a pair of boots made so as to content the eye of an anatomist, who knows what work is done by every bone, the main characteristic is, that when they stand side by side, with their heels in contact, the inner margins of the front part of the soles are along the whole edge corresponding to the sides of the great toes, also in contact. If it be desirable to point the toes, they must be pointed only from the outer side, after the place of greatest breadth in the foot has been properly respected. A certain sense of a turn inward belongs to the shape of boots so made, but if they fit perfectly they will insure to the foot the utmost ease and power; and, as their shape is of the ordinance of nature, they are no doubt really as elegant as those of which the pattern is a bootmaker's invention.

Dr. Meyer says that two or three persons in Zurich have had their boots made on these principles without exciting special remark — so immediately is the propriety of the change admitted even by the arbiters of fashion. As an evidence of its utility, a London journal mentions the fact that marching soldiers, who often break down in consequence of their shoes, would be rendered vastly more efficient if they were made in accordance with the structure of their feet.

ATMOSPHERIC WASHING-MACHINE.

At the last meeting of the British Association, Mr. J. Fisher called attention to a new washing-machine, the action of which was derived from streams of air forced through water from below, — the most effectual temperature of the water used being about 140° Fahrenheit. It was stated that machines on this principle, driven by steam power, had been for some time in successful use, in manufactories in England, for cleansing soiled laces.

IMPROVEMENT IN THE MANUFACTURE OF STARCH.

A patent has recently been issued in England for submitting starch — after it is deposited in the manufacturing process — to the action of a hydraulic press, in suitable boxes, so as to press all the water out, instead of evaporating all the moisture in artificially heated rooms, according to the usual practice. A great saving in fuel is thus effected by well-known and very simple means.

NEWSPAPER ADDRESSING MACHINE.

The following is a description of a newspaper addressing machine, invented by R. & D. Davis, of Elmira, N. Y., and recently introduced practically in several of the large newspaper offices of New York. The machin-

ery consists essentially of two distinct parts, one lettering the type or blocks with which the impressions are made, and the other doing the printing.

The lettering machine consists of a disk, or wheel, about eight inches in diameter, on the periphery of which are firmly-attached dies, representing the letters of the alphabet. By revolving this wheel or disk on its axis a die representing any desired letter is brought in position, and stamps its impress on a small block, when another letter is brought in position, and so on until the entire address is stamped, which is accomplished in about the same time required by a compositor to set the same number of types in a stick. A large number of these blocks, having been impressed with the addresses, are readily attached to a band, thus forming an endless belt of blocks. These belts are systematically arranged in boxes, so that any address may be referred to in a moment, for change or other purpose. When used, a belt is taken from the box and placed on the printing-machine ready for operation in a few seconds, when the impressions are made by a slight pressure with the foot, as rapidly as the papers or wrappers can be removed from the press. The entire apparatus is operated by hand, is simple, compact, cheap, requires no skill to work it, and is not liable to get out of repair, which renders it well adapted to papers of small as well as large circulation.

MEASURING FAUCET.

Whitman's measuring and registering faucet is simply a force-pump with a solid piston operated by a lever or crank. The cylinder is of the capacity of the unit of measure (pint, quart, etc.), and at each discharge an index on a dial-plate moves forward one degree. Mr. Whitman thinks this invention will supersede the use of funnels in grocery stores, abate the nuisance of flies about molasses casks, and detect frauds in the capacity of barrels. The faucet, made of cast iron, and capable of measuring quarts, is sold for four dollars.

NEW GRINDING AND POLISHING APPARATUS.

The New York Belting Company are now introducing a new form of emery wheel, which bids fair to supersede entirely the ordinary mode of covering a wheel with glue and sprinkling emery upon it. The emery is incorporated with India-rubber and sulphur, and while in a plastic state is put into moulds, and submitted, under great pressure, to a high degree of heat, according to Goodyear's patent for vulcanizing; this converts it into a solid granular mass, resembling granite or iron. It can be made of any desired grade of emery, and used either dry or with oil or water. The wheels can be turned off in a lathe, running very slow, in the same manner as iron is turned, which will enable parties using them to turn the face of the wheel to conform to work of any irregular shape, or to "true" them if necessary.

NEW MODE OF JOINING PIPES.

Mr. Siemens has exhibited at the London Institution of Civil Engineers a machine of his invention, manufactured by Messrs. Guest and Chrimes, for joining lead and other pipes by pressure only. The machine consisted of a strap of wrought iron, in the shape of the letter V, and of three dies, two of which were free to slide upon the inclined planes, while the third was

pressed down upon them by means of a screw passing through a movable cross-head, embracing the sides of the open strap. The pipes to be joinea were placed end to end, and a collar of lead was slipped over them. The collar was then placed between the three dies, and the pressure was applied by means of a screw-key until the annular beads, or rings, projecting from the internal surface of the dies, were imbedded into the lead collar. The machine was then removed, and a joint was formed capable of resisting a hydraulic pressure of eleven hundred feet. The security of the joint was increased by coating the surfaces previously to their being joined with white or red lead. The advantages claimed for this method of joining lead or other pipes, over the ordinary plumber's joint, were the comparative facility and cheapness of execution, as the cost of a joint of this description was said to be only about one-third or one-fourth that of the plumber's joint. A machine of a similar description was also used for joining telegraphic line wires, a specimen of which was likewise exhibited by Mr. Siemens.

BITUMENIZED PAPER PIPES.

The ingenious idea of hardening paper by means of an admixture of bitumen under the influence of hydraulic pressure, so as to convert it into a substitute for iron, is due to M. Jalourean, of Paris. The world has already become familiar with the utility and value of *papier maché* as a substitute for stone or marble in moulding, architectural castings, etc. It has also heard that the Chinese construct their cannon of prepared paper, lined with copper, and that they even make paper pipes; that an eccentric character has built himself a house of paper, and that our American friends have invented a veritable paper brick; but nothing, it is believed, has lately come before the British public, in the way of paper, so curious, and yet practicable, as these bituminous paper pipes. Testing experiments, conducted at the Houses of Parliament, are reported to have "proved that the material, while it possessed all the tenacity of iron, with one-half its specific gravity, had double the strength of stoneware tubes, without, moreover, being liable to breakage, as in the case of other material, and which frequently causes a loss to the contractor of some twenty or twenty-five per cent. on the supply." In order to test their strength, two of these bituminous paper pipes, of five-inch bore and half an inch thick, were subjected to hydraulic power, and they are said to have sustained, without breaking or bursting, a pressure of two hundred and twenty pounds to the square inch, or equivalent to five hundred and six feet head of water. The cost of the pipes is understood to be about one-half the cost of iron. — *London Builder.*

GAS METERS.

We make the following extract from the annual report of John C. Cresson, the engineer of the Philadelphia Gas Works:

Among the many subjects of a practical character that engage the attention of the gas engineer, none has given rise to more solicitude than the choice and management of gas meters, upon the accuracy and unvarying action of which the interests of both consumer and producer are in a great degree dependent; the former for his fair and uninterrupted supply of the commodity he pays for, and the latter for securing the due returns for his outlay of material and labor. All these desirable results are obtained in

great perfection from the instrument ordinarily known as the wet meter, so long as it is duly protected from frost and evaporative heat. Various contrivances have been suggested and tried for securing the instrument from these injurious influences. The most general practice is the substitution, in part or in whole, of alcohol for water as the hydraulic seal; but, while this guards against freezing, it gives rise to much inconvenience by reason of its rapid evaporation and want of specific gravity, which oftentimes cause a sudden obstruction of the flow of gas at the moment when the stoppage is most inconvenient to the consumer. A liquid free from these objections has long been desired, and, after numerous experiments, I had reason to suppose I had discovered it in the solution of neutral chloride of calcium. Accordingly, in the year 1843, I introduced this liquid into several hundred meters, for the purpose of giving it a fair practical test. It did not freeze at the lowest natural temperature of our climate, and the strong affinity of the salt for water prevented rapid evaporation; while its specific gravity, being greater than that of water, gave full support to the valve-float, and effectiveness to the hydraulic sealing. The results of the first year of trial were entirely satisfactory, and the liquid was then used in all the exposed meters with equally good results. But the expectations raised by two years of trial were dissipated at the end of the third year; by which time the metals of the meter showed such unmistakable evidences of the destructive action of the solution as led to its abandonment.

More recently I have been giving trial to another liquid, with encouraging prospect of success. It is the inert substance obtained from fatty bodies, and known by the name of glycerine. It is capable of resisting our lowest natural temperature, maintains its fluidity very pertinaciously, and is considerably heavier than water. Should it manifest no injurious action on the meter metals, or other defects, it will completely meet the wants of the instrument. A more direct method of escaping these liquid imperfections has been attempted in the so-called dry meter, working on the principle of the ordinary bellows, with diaphragms connected by flexible joints. A trial of these, on a large scale, during the years 1847 and 1848, revealed imperfections which impaired their trustworthiness so greatly as to require their entire disuse. Within a few years sundry improvements have been made in the construction of the dry meter, intended to remove the imperfections before mentioned, which seem to have sufficient merit to justify another trial. This has been in progress for nearly three years, with results, thus far, quite favorable; and if these shall be confirmed by longer and more extensive trial, the annoyances that have so long attended this part of gas machinery may be happily terminated.

COAL-OIL.

Although the manufacture of gas is rapidly extending in every direction, and the fact is becoming more widely known that in any town containing more than one thousand inhabitants a gas company can with profit be sustained, still, at present the number of gas works in operation in this country does not exceed four hundred, and consequently a large demand exists for other means of illumination. Coal-oil from its inexpensiveness, safety, and high photometric value, occupies an important place among the illuminating agents at present in use, and has given rise to an extensive trade, which cannot fail to be much increased, though at present it is somewhat depressed.

Extensive manufactories of coal-oil are now in operation at New York, Boston, Baltimore, Cincinnati, Philadelphia, Pittsburgh, Brooklyn, and many other places. The production will doubtless continue to augment, as the demand for prime qualities now exceeds the supply. It is to be regretted that much of the oil produced in this country is impure, containing a superabundance of the heavier hydro-carbons, which, except they are removed, produce smoke and fill the apartment with unpleasant odors. The remedy for these evils will be applied, and re-distillation, or some less wasteful and more efficient process of purification, will be adopted, as competition is excited and the manufacture progresses.

Of coal-oil lamps and burners, about 150,000 dozen are estimated to be in use, each lamp consuming about four gallons of oil during the year. The amount of oil burnt averages consequently 7,200,000 gallons a year, or about 20,000 gallons every day. To make 22,750 gallons of burning oil requires 75,000 gallons of crude coal-oil, or a consumption of 60,000 bushels of cannel coal. The erection of crude oil and refining works to make this quantity of oil each day will cost $3,000,000; but the actual outlay for the oil-works at present in operation does not fall short of $8,000,000. The value of chemicals used in the purification of coal-oil will amount to over $2,000 per day. The number of barrels used to hold coal-oil will be between 500 and 600, representing the value of $1,000 and the labor of 400 men. The aggregate value of the coal-oil itself will amount to $16,000 per day, or more than $5,000,000 a year. This, too, does not include heavy oil and paraffine, the sale of which is limited and uncertain. The number of workmen employed in the several coal-oil works in this country will reach 2,000; that of the miners engaged in mining cannel, 700 more. Besides these, a large force of men is employed in making lamps, burners, wicks, chemicals, etc. — *Gas Light Journal.*

THE AMERICAN SCREW CLOCK.

Large sums are annually paid in this country for fancy clocks imported from France and Germany, the value of which commonly consists more in their cases and tinsel work than in the excellence of their machinery and the accuracy of their movements. The cheap clocks of Connecticut manufacture, the wheels of which are cut out by dies, are quite as good time-keepers as most of the foreign clocks, and take their place in this country, and to some extent in Europe also, where correct time-keeping at least possible cost is alone desired. In these, and in watches made also on the same principle of multiplying the parts by machinery, so that the pieces may be put together indiscriminately, the American manufacture has of late years made great progress, lessening the foreign importations, and greatly increasing the use of these valuable instruments. But in ornamental clocks we are still dependent upon European manufacturers.

We therefore welcome the introduction of a beautiful ornamental clock, upon an entirely new principle, of great simplicity of design, and so constructed as to possess the accuracy of movement of a chronometer watch. Its works, however, are fully exposed to view under the glass that incloses them, and a better opportunity is thus afforded of learning the principles upon which this useful machine is constructed than from any other clock in use.

The clock to which we refer is a recent invention of Mr. James Tuerlynx,

of New York City. Its chief peculiarity consists in its motive power. Upon the circular metallic plate which forms the base of the clock is firmly fixed an upright steel screw, standing from ten to fifteen inches in height. A metallic ball of about two pounds weight is penetrated through its centre by this screw, and when at the upper end tends to run down the spiral inclined plane by revolving around it. By an ingenious arrangement, it is made to roll upon a little wheel attached to the top of the weight, without itself touching the screw; the friction is thus reduced to the least possible amount; and as by raising the weight this little wheel starts back and again catches in the thread of the screw at whatever point the weight is lifted, the only winding up required is simply to raise the weight, and for this a rod is provided, the upper end of which terminates in a ring or knob outside the clock, and the lower end in a circle, which takes the base of the weight as the rod is lifted. The revolution of the ball is communicated to the main wheel, which lies horizontally upon the bottom of the plate, by means of two rods that pass through the ball and are fixed to this wheel. A horizontal bar connects their upper ends, and the middle point of this bar is supported and turns upon the top of the screw. On this centre is the wheel, attached to the upper surface of the cross-bar, which regulates the movement of the hands upon the dial. The main wheel at the base is connected immediately with the escapement and balance-wheel, by which its motion is checked, and let out tick by tick with each swing of the balance. In these clocks the balance is on the compensation principle. The regulation is like that of a watch, and is reached by a wire introduced, when required, through a little hole made in the glass for this purpose. From the perfection of the works, and the holes being jeweled, the clock runs at regular rates, and as a timekeeper is probably not surpassed by any other of the same cost. The works are perfectly protected from dust, and the hands are covered by a glass like that of a watch, or, when inclosed, as in some of the clocks, under the glass cylinder, they may be reached through a hole made opposite to them in the glass, by a long key constructed for this purpose.

The important points in this clock are: first, the uniform manner of action of the motive power; second, its direct action upon the main wheel without the intervention of toothed wheels, which in other clocks introduce additional friction and causes of irregularity. The motive power required is thus lessened, and the wear proportionably reduced. It is variously constructed with one to three dials, and to run thirty-six hours, fifty hours, or eight days. For family use, no inconvenience is experienced in the use of those which run only thirty-six hours, as the position of the weight is at all times seen, and whenever at a low point is readily lifted by any member of the family. —*N. Y. Tribune.*

RECOVERY OF SILVER FROM SILVER-PLATED UTENSILS.

An important problem was that of readily obtaining pure silver from old, worn-out plated utensils of copper, etc. A recent number of the *Moniteur Scientifique* publishes valuable information on the subject, by M. Soelzel. The best method consists of treating the plated work by sulphuric acid, in which from five to ten per cent of nitrate of soda has been dissolved. The silver disappears, as if by magic, in this solution, before any of the copper is at all acted upon.

APPLICATION OF POISON TO THE CAPTURE OF WHALES.

Professor Christison, of Edinburgh, has recently published an account of some remarkable experiments for the capture of whales by poison. The agency employed was hydrocyanic, or prussic acid, inserted in glass tubes, and in weight about two ounces. After various trials to overcome the difficulty of discharging the poison from the tubes, a mode was arranged of attaching one end of a strong copper wire to each side of the harpoon near the blade, the other end of which passed obliquely over the tube, then through an oblique hole in the shaft, and finally to a bight in the rope, where it was firmly secured. When the harpoon struck the whale the tubes were crushed. On one occasion, a fine whale was met with; the harpoon was skilfully and deeply buried in its body; the leviathan immediately sounded, or dived perpendicularly downwards, but in a short time the rope relaxed, and the whale rose to the surface quite dead. The crew, however, were so appalled by the terrific effect of the poisoned harpoon that they declined to use any more of them; but Professor Christison is confident, from subsequent experiments, that success will be fully attained in this mode of capture.

NEW FIRE ALARUM.

An instrument has just been introduced, by Messrs. Taylor and Grimshaw, of London, which promises to be of great value as a fire alarm in warehouses, docks, vessels, and public establishments generally, as well as in private houses. It consists simply of an air-tight cylinder, with an India-rubber top, which, in proportion as the confined air becomes heated, expands and presses a spring, which, at any given elevation of temperature, will set free a common alarum, or fire a pistol or cannon. It is likewise capable of being adapted to furnaces, conservatories, and every place where exact ventilation is requisite, since the spring, instead of sounding an alarum, can be made to act upon an aperture for admitting air. It is portable and inexpensive, and the principle seems likely to be applied to a number of important commercial uses.

A NEW FORM OF BATH.

M. Mathieu (de la Drôme), a well-known French orator, has lately been turning his attention to the subject of medicinal baths. A bath by immersion requires from two to three hectolitres of water, which in the case of mere river or spring water is of no consequence as regards expense. But the case is far different when the water is to be impregnated with medicinal substances, some of which are very costly; or when mineral waters are prescribed, which cannot be had in large quantities without considerable outlay, except at the spring from which they are derived. M. Mathieu (de la Drôme) has therefore endeavored to ascertain, both by calculation and experiment, what is the real quantity of water which produces a useful effect on a human body in a common bath, and has found that it cannot be more than three or four litres in the course of an hour. To distribute this quantity both equally and economically on the body was, therefore, the question to be solved; and he has accordingly invented an apparatus, which he calls *bain hydrofère.* The patient is seated in a kind of box like that used for fumigation, while a powerful ventilator outside transforms the

water which is to be used into a minute aqueous dust or dew, just as we see a high wind do with the water issuing from the jets of a fountain. This dew is driven into the box through an aperture on a level with the knees; and owing to the extreme minuteness of its particles, the latter ascend, and then gradually subside on the body. In a short time these particles coalesce and trickle down the body, until at last the water descends in an unceasing stream. This system has now been tried with great success at the Hôpital St. Louis, and is generally attracting the attention of medical men.

LIQUID GLUE.

As long ago as 1852, Dumoulin published a notice in the *Comptes Rendus* of the French Academy with reference to the preparation of a liquid glue. He was led to the discovery of a method of procuring it by considering the long-known fact that when solution of glue is frequently heated and cooled, or kept a long time exposed to heat, it loses its property of gelatinizing by cooling, and remains liquid. Under the impression that this change might be caused by the action of the oxygen of the air, and, if so, would be induced more speedily by some vigorous oxidizing agent, Dumoulin tried the effect of dilute nitric acid on glue, and shortly found that by its use the product he desired was easily obtained. His method of preparation was as follows: The best Cologne glue is dissolved, at a gentle heat, in an equal weight of water contained in an enamelled or glazed vessel, and when the solution is complete, nitric acid of thirty-six degrees Beaumé is added in proportions, and at intervals, to the amount of one-fifth of the weight of the glue employed. Nitrous vapors are abundantly given off, and a glue is obtained that is perfectly fluid, and may be kept in open vessels for years without alteration. Already, in 1852, this preparation was sold in Paris as inalterable liquid glue (*colle liquide et inalterable*). A better liquid glue than that just described is made with acetic acid. One pound of good glue is dissolved, with heat, in a mixture composed of one pound of strong vinegar, one-quarter of a pound of alcohol, and a very little alum. According to Cavallius, however, alum destroys the tenacity of glue, and should be avoided. In order to make the glue white in color, a quantity of sulphate of lead is added to the solution. The liquid glues now so extensively sold in this country are made with acetic acid, and those we have tested are very excellent preparations. A glue that is liquid at low temperature is not so adhesive as one which requires gentle warming to make it flow. Solutions of chloride of barium, bichromate of potash, and some other salts, as well as all the various mineral and vegetable acids, also have the property of holding glue in permanent solution.

THE ART OF DENTISTRY.

Few persons realize the rapid growth of dentistry as a profession. Forty years ago doctors officiated as tooth-pullers, and if decay seized upon a molar it accomplished its work unimpeded. It is an actual fact that in 1820 there were hardly more than thirty practising dentists in this country. Ten years after that, the invention of artificial teeth had given such an impetus to the profession that the thirty had increased to 200. In 1842 it was estimated that there were 1,400; in 1848, 2,000. In 1850, the census reported 2,923 practising dentists; and at the present time there must be at least 5,000.

American ingenuity long since superseded the artificial teeth which were at first manufactured by the French. In twenty years the number of teeth made here has increased from 250,000 to 5,000,000. For all these grinders we cannot find occupation, and a large portion are exported. The capital employed in this single branch of industry is upwards of $500,000. A single firm in Philadelphia use 700 moulds, producing 9,000 different shapes and styles of teeth, costing upwards of $18,000. Of platina alone 300 ounces a month are used simply for pins to fasten the teeth in their places. This firm manufactures 180,000 finished teeth per month. The value of gold-foil it sells amounts to $109,200 per annum. It is estimated that the 5,000 dentists in the country use no less than $2,500,000, worth of gold per annum.

MEDALS IN ALLOYS OF PLATINUM AND IRIDIUM.

M. Pelouze recently presented to the Academy of Sciences at Paris, in the name of M. Jacobi, medals of different sizes struck in alloys of platinum and iridium, fused at the laboratory of the *Ecole Normale*, by the process of MM. Deville and Debray. The alloys contained respectively twenty, ten, and five per cent of iridium. According to the declaration of M. Jacobi, they were rolled cold and without annealing, with great ease, and presented the characters of the most ductile metals. Under the press they take a polish equal to that of coins; and the alloys rich in iridium showed a hardness rather greater than that of gold of 0·916. This hardness is proportioned to the quantity of iridium, as is also the resistance of the alloy to aqua-regia, which attains its maximum when the quantity of iridium reaches twenty per cent.

WEAR OF GOLD AND SILVER COINAGE.

The *Gazette* of St. Petersburg gives a curious account of an experiment recently made at the mint of that city for the purpose of ascertaining the comparative loss by ordinary wear of gold and silver coin. It appears, contrary to the generally received opinion, that gold wears away faster than silver. The means employed were as follows: Twenty pounds of gold half-imperials, and as much of silver copecks, — coins of about the same size, — were put into two new barrels, mounted like churns, which were kept turning for four hours continuously. It was then found, on weighing the coins, that the gold coins had lost sixty-four grammes, while the silver coins had lost only thirty-four grammes; but as the number of gold pieces was twenty-eight per cent. less than those of silver, the proportion is greater to that amount in favor of the latter. It must, however, be mentioned that the silver contained more alloy than the gold, the standard of the former being 868-1000ths of pure metal, and that of the latter 916-1000ths. The result of the experiment is, that the pecuniary loss on the wear of gold coin is about thirty times more than on silver.

STONE-DIGGING AND WALL-LAYING MACHINE.

We were recently invited to witness, says the New York *Tribune*, the trial of a machine for digging stones and building wall. The novelty of a machine for such labor excited a good deal of incredulity as to the possibility of substituting mechanical for manual labor in this hardest of farm work;

and it was difficult to believe the statement that it would take rocks of five tons' weight out of the ground without digging around them.

But seeing is believing; and we have witnessed the machine in actual operation, taking out boulders weighing from one to five tons, and from one-half to seven-eighths under ground, at the rate of one every three minutes. The machine is a compact and stout iron windlass, on wheels, drawn by one pair of oxen, while another pair, immediately in front of them, are hitched to a rope which works the windlass through cog-wheels, multiplying the power some twenty times. The windlass can also be worked by hand, in which case the power is multiplied twice or three times as much. Two very heavy chains are fastened to and reeled upon the barrel of the windlass; they support a hook in whose jaw is hung a piece of chain, which can easily be lengthened or shortened. This chain is reeved through the shanks of the huge hooks which take hold of the rocks. The rocks are previously fitted for the machine by drilling holes in opposite sides, about three-quarters of an inch deep. The machine is driven over a rock; the man at the windlass — which is so high that a rock of five or six tons can be lifted two feet from the ground — lowers the great grappling hooks; the man below adjusts their points in the holes in the sides of the rocks, lengthening or shortening the chain holding the hooks as the rock is larger or smaller; the man at the windlass then tightens the slack, while the man below gets upon the machine; then both heave at the windlass. If they do not start the rock, the driver helps them, and if the three cannot, it is given up as liable to break the machine. If they do start it, they tell the driver to go ahead, and he drives on the forward team, winding up the windlass. The rock rises out of the ground, and the team yoked to the machine then draws it wherever it is wanted. It can be laid as the bottom stone of a wall, or, if the bottom stones are laid, the machine can be backed up to the wall, and the rock pulled over by the other pair of oxen, and laid on the wall.

This all seems very simple and easy, and it is easier than it seems. The holes drilled in the rocks were so shallow that we were expecting all the while that the hooks would slip, or would break away the rock, when the enormous lifting power required to lift it and tear away the earth which wedged many of them down came to be applied. But they did not, and in some cases the hooks were applied even without drilling holes for them. It is a wonder that, among all the inventive Yankees who have spent so many lifetimes digging out rocks with spades, and levers, and chains, and oxen, nobody should have thought of this before. Mr. S. E. Bolles, of Plymouth, Mass., the inventor of the machine, got his patent for it five years ago; but it is only lately, and through an enterprising farmer, that it has been brought to the notice of the public. The machines appear to be very solidly built. They weigh a little over a ton, and cost, aside from the patent right to use them, two hundred and twenty-five dollars. Messrs. Knapp & Co. offer to take out all the rocks weighing between one and five tons, on any ordinary piece of ground in the counties for which they hold the patent right, at seventeen dollars per hundred. They say it costs three or four times as much to do it in the old way, and that many pieces of ground, which would not pay for clearing up in the old way, can now be smoothed off at a profit.

IMPROVEMENTS IN AGRICULTURAL IMPLEMENTS.

Corn-Cutter and Shocker. — J. H. Reble, of Dayton, Ohio, has recently brought into operation a novel agricultural implement, in the shape of a corn-cutter and shocker. The machine is about eight feet wide, and drawn by two horses. It cuts the standing maize by means of vibrating knives like those of a mower, and throws it over backward on to a scoop-shaped platform, where the butts are properly arranged by an assistant, who stands behind the driver, and has a suitable long-handled hook for the purpose. The tops of the stalks lie in a pair of arms, and when enough have accumulated — say one hundred to one hundred and fifty hills — to make a shock, they are compressed by means of a rope and windlass; a binding-string is tied around them, and the shock is first raised upward and carried backward by a lever which raises a section of the platform, and then tilted up so as to be discharged on the ground right side up. The machine then drives on and repeats the same operation. It requires two horses to draw the shocker, and three men to work it.

An improved Hook for a Whiffle-tree, from which the trace never can get loose, however slack it may be, when in use, while it is also as handy to hitch and unhitch as one of the ordinary kind, is a new and successful contrivance. This hook is attached to the whiffle-tree by an iron strap, plays loosely up and down, and turns quite round behind the whiffle-tree, where alone the trace can be hitched and unhitched. As soon as it slips from that position, the hook fits close to the iron at every other point, whether pulled tight or left slack. Naturally, when the trace is slack, the hook falls and hangs by its own gravity below the whiffle-tree, but it is almost, if not quite, impossible that it should turn round upon the rear side so as to unhook.

An Improvement in the construction of a Corn-knife, or Tree-pruning Knife, consists in an iron attachment to the end of the handle, which is made to reach up along the under side of the arm nearly to the elbow, where it is loosely buckled. This gives all the strength and leverage of the forearm to relieve the strain upon the wrist.

A new Churn, says the New York *Tribune,* has appeared, which, we believe, will give greater satisfaction than any of its almost innumerable predecessors. Heretofore we have found no substitute for the old hard-working but effective dasher churn; but one has, we think, at last been invented. This new churn will make more and better butter from a given quantity of cream than any other we have ever seen, and in a reasonable time, usually less than half an hour. Nor has it any machinery to adjust or keep in order, and nothing but a plain, smooth barrel, inside and out, to keep clean. A child can fill it, churn it, empty it, wash it, with less strength than it takes to lift a bucket of water. It has no dasher, but is simply a plain barrel, of any required size, hung upon iron pivots in a frame, and made to revolve end over end by a crank, the cream dashing back and forth. One end of the barrel is made movable and convenient to take off, and is fastened on by a thumb-screw, air tight. After the cream is put in and the cover fastened down, a small air-pump is attached, and the barrel charged with air, and then revolved. Without attempting a reason, we will say that this aërifying has a remarkable and beneficial effect upon the cream, and apparently improves the quantity and quality of the butter.

Improved Horse Shoe. — A patent has recently been granted to W. Coleman,

of Philadelphia, for a device for relieving the feet of horses from the concussion to which they are liable in passing over pavements. It consists in combining with the shoe a layer of India-rubber and what is called hoof-plate, the rubber being placed between the shoe and the hoof-plate, and the hoof-plate attached to the foot. By this arrangement, while the rubber is removed from contact with the foot, and is so secured as to be permanent and durable, its elasticity is at the same time made available.

New Ploughing Machine. — A novel ploughing machine has recently been patented by R. F. Hudson and H. G. Pomeroy, of New York City, which operates as follows: —

We may suppose two cart-wheels with gearing upon the inner face of the spokes which drives three shafts hung in an oscillating frame, and lying back at the rear of the axle, by which three furrows, each a foot wide and a foot deep, are not only to be turned over, but thoroughly stirred up and pulverized; the operation being something like worming a screw through the soil, in so rapid a manner that it keeps the earth flying around in a circle, and that of the three diggers mixing through each other.

ON THE DECAY AND PRESERVATION OF BUILDING MATERIALS.

The following is an abstract of a recent lecture before the Royal Institution of Great Britain, on the above subject, by Prof. Austed.

He commenced by directing attention to the state of the stone in many of the principal buildings in England and on the Continent, illustrating the extreme irregularity with which various materials, and even various samples of the same material, resist the action of the weather, and fall into decay. He then described the chief building materials, explaining in each case the cause of decay. Commencing with a general remark, that all stones are rotten and weathered at the top of a quarry, or near an earthy surface, and that the action of the weather on them is in some measure thus indicated, he first alluded to granite. He stated its properties of hardness and great durability in ordinary cases, but remarked that when soda replaced potash in the felspar, the crystals of felspar were subject to the action of the weather, and that, from some cause little known, the silica base also occasionally failed. Still, the great practical objection to the use of granite is its cost. Passing next to the sandstones, he defined them, mentioning the chief varieties. He stated that the nature of decay in sandstones was generally the failure of the cementing medium, which is sometimes silicious, but more frequently calcareous, or clayey, or even oxide of iron. He pointed out as the causes of decay, the want of sufficient cohesion in the cementing medium, the nature of the cementing medium itself, and the effect of expansion and contraction of water absorbed by the stone. The limestones were next considered, and the principal varieties passed briefly under review. They are all freestones, — some are crystalline, others semi-crystalline, but most of them are earthy, or oölited and absorbent. They consist of particles of carbonate of lime, whether grains, as in the case of chalk, or accumulated lumps, like oölite or roe-stone, or fragments of shell; and these particles are cemented together by carbonate of lime. The stones are generally laminated, though the bedding is often extremely obscure. When exposed to the action of the air in towns, they absorb moisture and acid gases very readily, and the result is a gradual destruction

of the surface, and often a rapid removal of the particles beneath the surface, especially on the planes of bedding. When stones are not placed in a building as they were in the quarry, the surface peels off in natural films, and is more rapidly acted on than it need be; but not unfrequently, even when well placed, the surface gets hardened by exposure more rapidly than the substance of the stone, and a scaling still takes place. The more exposed parts, those subject to drip and constant damp, and the more delicately sculptured portions, are among the first to decay; and, owing probably to differences in the mode or rate of deposit of the mud of which the limestone was formed, or some partial change that has since taken place, there is great irregularity in the rate of decay. Magnesian limestones, or dolomites, when quite crystalline, behave like marble; but when, as is usual, only half crystalline, they are very apt to become reduced to powder in parts, and the decay thence proceeds with extreme rapidity. The professor next proceeded to consider the remedies for decay. He alluded to paint as at once unsightly and not permanently beneficial, and included the large class of preservatives that have been suggested, in which any animal or vegetable oil or fatty matter was contained, as equally valueless, either peeling off, or rotting in the stone, and leaving it soon exposed to ordinary decay. The mineral bitumens, he stated, had not been much tried, owing to their dark, unsightly color. What is required is some mineral preparation. He then alluded to the water-glass, a soluble silicate of potash, originally described by Dr. Fuchs, and applied to indurate stone by M. Kuhlmann. He explained the principle of this process as depending on slow decomposition by exposure to the air, and stated that, as meanwhile the influences of the weather continued to act, the method could not be adopted with advantage in the open air in a damp climate, where preservation is chiefly required. The only plan that, as far as he was aware, met the requirements of the case, he stated to be that adopted by Mr. Ransome, according to which the absorbent surface, whether of stone or terra-cotta, was saturated with the diluted solution of soluble silicate of soda, and then treated with a solution of chloride of calcium. By the mutual action of these solutions, a double decomposition is induced, the silicic acid parting with its soda to the chlorine, producing chloride of sodium, or common salt, and combining with the lime to form silicate of lime. The salt being washed away, only the silicate of lime remains. The silicate of lime, thus thrown down, he next explained to be a salt, which was not only itself non-absorbent, and singularly powerful in resisting the action of ordinary atmospheric influences, but as having the property of adhering readily to the surface of the minute particles of which stone was formed. He illustrated this by the case of mortar and concrete, which owe their adhesive properties to this habit of silicate of lime, which is the mineral formed by the mutual action of the cement on the substances in contact with it. The stone having its particles thus coated with silicate of lime, and all the absorbent surface being thus protected, the result is an immediate and great hardening of the stone, so far within its substance as the solutions have been absorbed, and a complete immunity to that extent from the action of atmospheric influences. The stone does not necessarily become non-absorbent, though it can be made so; but it absorbs much less rapidly than before, and appears to resist decay much in the way that some of the best natural sandstones are known to do.

ZEIODELITE—A NEW MINERAL PASTE.

The London *Chemical News* describes, under the above name, a new kind of paste, discovered by Joseph Simon, which becomes as hard as stone, is unchangeable by the air, and, being proof against the action of acids, may replace lead and other substances for various uses. It is made by mixing together nineteen pounds of sulphur and forty-two pounds of pulverized stoneware and glass. The mixture is exposed to a gentle heat, which melts the sulphur, and then the mass is stirred until it becomes thoroughly homogeneous, when it is run into suitable moulds and allowed to cool. This preparation is proof against acids in general, whatever their degree of concentration, and will last an indefinite time. It melts at about 120° Centigrade, and may be reëmployed without loss of any of its qualities, whenever it is desirable to change the form of an apparatus, by melting at a gentle heat, and operating as with asphalte. At 110° Centigrade it becomes as hard as stone, and therefore preserves its solidity in boiling water. Slabs of zeiodelite may be joined by introducing between them some of the paste heated to 200° Centigrade, which will melt the edges of the slabs, and when the whole becomes cold it will present one uniform piece. Chambers lined with zeiodelite in place of lead, the inventor says, will enable manufacturers to produce acids free from nitrate and sulphate of lead. The cost will be only one-fifth the price of lead. The compound is also said to be superior to hydraulic lime for uniting stone and resisting the action of water.

PLASTIC COMPOSITIONS IN LIEU OF MARBLE.

A Mr. Brooman, of London, has invented a composition, to be used for building and decorating purposes in lieu of marble, which he calls "similimarble." A communication in the London *Engineer* describes the process of manufacture as follows:—

To manufacture similimarble intended to remain white, take sulphate of potass about fourteen ounces; river water, sixteen quarts; gum arabic, two pounds; purified cement, twenty pounds; marble or alabaster powder or dust, twenty pounds; and treat as follows: First mixture—Dissolve over a slow fire, stirring all the time, fourteen ounces of sulphate of potass in sixteen quarts of water; after fusion, dissolve two pounds of gum arabic. Second mixture—Stir together twenty pounds of purified cement, twenty pounds of marble or alabaster dust, and five pounds of lime, slacked sufficiently to cause it to crumble into powder. Pour into a mortar of marble, porcelain, or other suitable material, a part of the first and a part of the second mixture, and stir with a wooden or bone spatula until the ingredients assume the state of thick paste; then beat with a pestle until the mass becomes elastic, which will be ascertained by the composition not adhering to the pestle. To make mouldings or castings, grease the mould, and apply a first layer of about one-third of an inch in thickness of the composition as aforesaid; this first layer is backed by another, formed by boiling, for about three or four hours over a brisk fire, hemp, tow, or other filamentous substances, cut small, in the "first mixture" of gum and sulphate of potass. The product is mixed with the "second mixture" in a mortar, and well beaten with a pestle until the filamentous parts are divided through the mass, and the whole reduced to a paste. Thus a composition of great solidity and impermeability is produced, lighter than and taking an equal polish to marble, and resisting the action of frost better than marble.

FIRE-PROOF COMPOSITION TO RESIST FIRE FOR FIVE HOURS.

Dissolve, in cold water, as much pearlash as it is capable of holding in solution, and wash or daub with it all the boards, wainscoting, timber, etc. Then, diluting the same liquid with a little water, add to it such a portion of fine yellow clay as will make the mixture the same consistence as common paint; stir in a small quantity of paper-hanger's flour paste to combine both the other substances. Give three coats of this mixture. When dry, apply the following mixture: Put into a pot equal quantities of finely pulverized iron filings, brickdust, and ashes; pour over them size or glue water; set the whole near a fire, and when warm stir them well together. With this liquid composition, or size, give one coat; and on its getting dry, give it a second coat. It resists fire for five hours, and prevents the wood from ever bursting into flames. It resists the ravages of fire, so as only to be reduced to coals or embers, without spreading the conflagration by additional flames; by which five clear hours are gained in removing valuable effects to a place of safety, as well as rescuing the lives of all the family from danger. Furniture, chairs, tables, etc., particularly staircases, may be so protected. Twenty pounds of finely sifted yellow clay, a pound and a half of flour for making the paste, and one pound of pearlash, are sufficient to prepare a square rood of deal boards. — *London Builder.*

EXCLUSION OF DAMP FROM BRICKWORK.

The following methods for obviating this evil have been described at the Royal Institute of Architects: Three quarters of a pound of mottled soap are to be dissolved in one gallon of boiling water, and the hot solution spread steadily with a flat brush over the outer surface of the brickwork, taking care that it does not lather; this is to be allowed to dry for twenty-four hours, when a solution formed of a quarter of a pound of alum dissolved in two gallons of water is to be applied in a similar manner over the coating of soap. The operation should be performed in dry, settled weather. The soap and alum naturally decompose each other, and form an insoluble varnish which the rain is unable to penetrate; and this cause of dampness is thus said to be effectually removed. The other method consists of sulphurized oil as a varnish or paint, and is said to improve the color of brick and stone, as well as preserve them. It is prepared by subjecting eight parts of linseed oil and one part of sulphur to a temperature of 278° in an iron vessel. It is said to keep out both air and moisture, and prevent deposits of soot and dirt, when applied with a brush to the surface of a building of brick or stone, or even of woodwork. — *London Builder.*

ON THE USE OF GRANITE. — BY GARDNER WILKINSON.

As the question of using granite for building and monumental purposes has been much discussed, I would call attention to a fact, which shows at how early a period the ancient Egyptians had watched the effect of atmospheric and other influences on stone, and how wisely they had profited by the lessons taught them by experience. They had learned that earth abounding in nitre, from its attracting moisture, had the effect of decomposing granite, but that in the dry climate of Upper Egypt the stone remained for ages uninjured when raised above all contact with the ground.

When, therefore, there was a possibility of its being exposed to damp, they based an obelisk, or other granite monument, on limestone substructions; and these last are found to the present day perfectly preserved, while the granite above them gives signs of decay in proportion to its contact with the earth subsequently accumulated about it. I am speaking of Upper Egypt, visited only four or five times in a year by a shower of rain; for in the Delta granite remains have been affected in a far greater degree than in the Thebaïd. Nitre abounds there, and it is remarkable that the obelisks at Alexandria have suffered least on the sides next the sea.

The Egyptians seldom used granite as a building-stone, except for a small sanctuary in some sandstone temple; and in the later times of the Ptolemies one or two temples were built entirely of granite. But in the pure Egyptian period, that stone was chiefly confined to the external and internal casing of walls, to obelisks, doorways, monolithic shrines, sarcophagi, statues, small columns, and monuments of limited size, and was sometimes employed for roofing a chamber in a tomb.

The durability of granite varies according to its qualities. The felspar is the first of its component parts which decomposes, and its greater or less aptitude for decay depends on the nature of the base of which the felspar consists. Egypt produces a great variety of granite, and the primitive ranges in the desert east of the Nile, about thirty-five miles from the Red Sea, supplied the Romans with numerous hitherto unknown kinds, as well as with porphyry, which they quarried so extensively in that district; but the granite of the ancient Egyptians came from the quarries of Syene, in the valley of the Nile, and from these they obtained what was used for their monuments. It is from this locality that the name of "Syenite" has been applied to a certain kind of granite; it is, however, far from being all of the same nature, and a small portion of the stone found there is really what we now call "Syenite."

Already, at the early period of the third and fourth dynasties, between twelve and thirteen centuries before the Christian era, the Egyptians extensively employed granite for various purposes. They had learnt to cut it with such skill that the joints of the blocks were fitted with the utmost precision. Deep grooves were formed in the hard stone with evident facility; and it must have been known to them for a long period before the erection of the oldest monuments that remain, — the pyramids of Memphis, — where granite was introduced in a manner which could only result from long experience. Again, in the time of the first Osirtasen, about 2050 B. C., granite obelisks were erected at Heliopolis and in the Fyoóm, and other granite monuments were raised in the same reign at Thebes, from which we find that even then the Egyptians had learnt how the damp earth acted on granite when buried beneath it; and this interesting question subsequently suggests itself: How long before that time must the stone have been used to enable them to obtain from experience that important hint which led them to place granite on limestone substructions?

WHAT SHOULD MECHANICAL WORKMEN BE TAUGHT?

The following extracts from an address on the above subject, recently delivered at the South Kensington Museum, London, by J. Scott Russell, F. R. S., contain some views on the education of mechanical workmen which are both novel and interesting.

Students in schools were now taught geometry; they were taught the sixteenth, seventeenth, eighteenth, and nineteenth propositions of Euclid; but that description of knowledge was not of the slightest use to his workmen, or to anybody else. They were also taught mechanics and the law of the lever. That was right; but, then, mechanics and the law of the lever were not ordinarily taught in books in such a way as to be of practical use to the British workman. We did not go far enough. But the pupil teachers whom he addressed were not to blame. The persons to blame were their teachers. Two years was, perhaps, all the time that could be devoted to education, and six months were often devoted to as many books of Euclid, which were wasted for all practical purposes, unless, indeed, the student intended to become a professor. He would advise them to skip over the beginning, and devote the least possible time to Euclid; in fact, he would advise them to do a very heterodox thing — to cut off all the propositions but the useful ones. They might naturally exclaim, "Then how little will be left." Very little, he admitted; but plane trigonometry would be left. Suppose, for instance, a man had but six months in which to learn. Six weeks might, in that case, be given to Euclid, and then trigonometry might be commenced, solid geometry might next follow, and that constituted the whole education of the workman. But that was precisely what he did not get in the present day. He would also teach, in the six months, conic sections, and afterwards the nature of curves, within the first, second, third, and fourth degrees.

What he had said about geometry was true as to mathematics. Thirteen and a half yards at three and a half cents was not what was wanted. Of far more importance to the working-man was the comprehension of the laws and relations of numbers, so as to enable him to think in figures about the immediate business before him. The first and most important doctrine to remember in mathematics was, that shape is not size, or size shape. This might appear to be an axiom, and he thought it was as good as any in Euclid. The doctrine of similar triangles was a fundamental principle entitled to the dignity of an axiom; and it was that, without regard to shape and size, any number of triangles might be made all of the same shape, and not of the same size. Mr. Russell having illustrated this principle by drawings on the board, continued to say that, with respect to solid geometry, the two great duties in a workman's life were conversion of materials and adaptation to strength. A mason who used up a wrong stone, or a carpenter who selected a wrong plank or piece of timber, showed that he was ignorant of one of the most useful portions of his art or calling. Now, nothing would teach conversion of materials like solid geometry; it was, in fact, the daily business of the workman. It had been said that every block of marble cut from the quarry contained a beautiful statue, but the art was how to get it out of it. This was very true; but what workmen wanted to know was every shape, and how to get out another shape. The workman who took from a heap a block of stone or piece of timber that cost his master fifty shillings, when a piece could be got answering quite as well which cost twenty-five shillings, inflicted a loss upon his employer perhaps equal to a week's wages. Hence the necessity of acquiring a knowledge of solid geometry. But if there were beauty in the quantity of numbers, and in regular geometrical figures, there was infinitely more beauty in curves. It was the duty of many mechanics, especially of those engaged in ship-building, to make curved lines. To him it had always been an interesting subject to learn how

curves grew. He was aware that he might be told that the higher curve, were never taught; but his answer was, that they might easily be taught, and that they were very easy of comprehension. In order to effect this, somebody who understood the subject would have to be prevailed upon, not to write a book, but to put down in the shortest and plainest language what he knew of curves. This would be a treatise which the workman could understand. The lecturer then explained, with the aid of the board, the various mathematical figures known as conic sections, parabola, ellipses hyperbola, and the movement of the comets. These, he contended, might be learned so as to make the workman master of the principle within six months. He also thought that there ought to be a large quantity of apparatus — a sort of inventory of education — of every conceivable shape and object. In addition to these models, he would have the school-room hung round, not with pictures of animals, but with solid bodies, which could be explained and drawn. He would, in fact, impart any kind of practical rather than book knowledge. If drawings merely were used instead of models, he did not think the student could imbibe so correct a notion of the object to be produced or delineated. There was a mode of studying forms called *la théorie de développement*, but the plain English meant nothing more than making flat surfaces into round and angular forms, as models now made from sheets of paper, which was a most valuable mode of studying forms. Machinery could now be obtained to do all the unintellectual drudgery of mechanism. He was not opposed to machinery, and had no apprehension that it would supersede skilled intellectual handicraft. He would employ machinery to do all the drudgery that degraded the workman into a beast of burden. He would give him higher views of mathematics; he would show him that he was an intellectual, thinking being, with a soul for high and immortal things.

IMPROVED NAILS.

A French mechanician states that nails formed with two sloping edges may be driven into thin wood without risk of splitting it, provided they are made to cut the wood across the grain. He recommends manufacturers to make nails of this kind in order to save carpenters the trouble and loss of time involved in using a gimlet or brad-awl.

A GREAT MACHINE FOR A SIMPLE PURPOSE,—TURNING BAGS BY STEAM.

We have recently examined a machine more complicated than a stocking loom for the simple purpose of turning cloth bags (after they have been sewed or woven) the right side out! "Can it be," we asked the inventor, "that there is a demand for machinery for performing so trifling an operation as this?"

"O, yes," he said; "it takes as much time to turn a bag as it does to make it, at the present day. In our neighborhood there are two large cotton manufactories devoted exclusively to making cloth for bags. In the country there are probably three hundred bag manufacturers, employing from two to fifty turners each, and one of these machines will do the work of thirty hands. One of the large manufacturers in this city told me that the machine, besides saving in wages, would enable him to effect considerable economy in his rent,

from the small room occupied by the machine in comparison with all the hands he now employs for turning."

The machine works in the most accurate, rapid, and beautiful manner, but it would be difficult to give any clear idea of its ingenious mechanism without diagrams. — *Scientific American.*

IMPROVEMENT IN GAS-BURNERS.

A patent has been recently taken out in England for a gas-burner of the following simple construction, designed to prevent the flickering of the light. It consists of a tubular cap of thin cast-iron or other metal, having a wide internal diameter, so as to fit by its open lower end upon or over an existing burner. The top of the burner is in the form of a solid convex end, through which a vertical slit is made to form the actual burner aperture for the gas, and produces a thin, broad, flat flame. When such a tubular cap is fitted upon or over an ordinary burner, the gas is received into the reservoir of the tubular cap, and it thence passes slowly off through the burner slit. The reservoir intervening between the common burner beneath and the burner slit in the top of the cap above, acts as a pressure-regulator, to prevent flickering and inordinate forcing of the gas, whilst the broad flame insures the production of a brilliant light. — *Scientific American.*

NATURAL PHILOSOPHY.

ON PHYSICS AS A BRANCH OF THE SCIENCE OF MOTION.

THE following are the chief points of a paper on the above subject, presented to the British Association, 1860, by J. S. Glennie:

The object of the author was not to enter into the full subject, but, by submitting it to discussion, to gain the advantage of criticism. He conceives atoms as mutually determining centres of pressure,— that is, more definitely, as centres of lines, the intensity and direction of which are determined by the intensity and direction of the lines from surrounding atoms. Thus, atoms are neither conceived as particles of matter, acted on by extraneous forces of attraction and repulsion, nor as vague centres of force; and that pressure generally is conceived as measured by M. O. Motion is not conceived as "a quality of matter, of which no further account can be given," but as the effect in any place of a difference of the polar pressures on a body in that plane. The principle to which the author most constantly has to refer is, that "the motion of a body is in the direction of least resistance; or, motion is the effect of, and proportional to, the difference of polar pressures. From thence, by a train of mixed metaphysical and mathematical conceptions, to deduce that gravity, the law of universal attraction, is the mechanical consequence of difference in the masses of a system, mutually connected by their lines of pressures and repelling; and that thus the law of the inverse squares is rather a mathematical than a physical law.

ON THE NECESSITY FOR INCESSANT RECORDING, AND FOR SIMULTANEOUS OBSERVATIONS IN DIFFERENT LOCALITIES, TO INVESTIGATE ATMOSPHERIC ELECTRICITY.

The following is an abstract of a paper on the above subject presented to the British Association, Aberdeen, by Professor W. Thompson:

The necessity for incessantly recording the electric condition of the atmosphere was illustrated by reference to observations recently made by the author in the island of Arran, by which it appeared that even under a cloudless sky, without any sensible wind, the negative electrification of the surface of the earth, always found during severe weather, is constantly varying in degree. He had found it impossible, at any time, to leave the electrometer without losing remarkable features of the phenomenon. Beccaria, Professor of Natural Philosophy in the University of Turin a century ago, used to

retire to Garzegna when his vacation commenced, and to make incessant observations on atmospheric electricity, night and day, sleeping in the room with his electrometer, in a lofty position, from which he could watch the sky all round, limited by the Alpine range on one side, and the great plain of Piedmont on the other. Unless relays of observers can be got to follow his example, and to take advantage of the more accurate instruments supplied by advanced electric science, a self-recording apparatus must be applied to provide the data required for obtaining knowledge in this most interesting field of nature. The author pointed out certain simple and easily-executed modifications of working electrometers, which were on the table before him, to render them self-recording. He also explained a new collecting apparatus for atmospheric electricity, consisting of an insulated vessel of water, discharging its contents in a fine stream from a pointed tube. This stream carries away electricity as long as any exists on its surface, where it breaks into drops. The immediate object of this arrangement is to maintain the whole insulated conductor, including the portion of the electrometer connected with it and the connecting wire, in the condition of no absolute charge; that is to say, with as much positive electricity on one side of a neutral line as of negative on the other. Hence the position of the discharging nozzle must be such that the point where the stream breaks into drops is in what would be the neutral line of the conductor, if first perfectly discharged under temporary cover, and then exposed in its permanent open position, in which it will become inductively electrified by the aërial electromotive force. If the insulation is maintained in perfection, the dropping will not be called on for any electrical effect, and sudden or slow atmospheric changes will all instantaneously and perfectly induce their corresponding variations in the conductor, and give their appropriate indications to the electrometer. The necessary imperfection of the actual insulation, which tends to bring the neutral line downwards or inwards, or the contrary effects of aërial convection, which, when the insulation is good, generally preponderate, and which, in some conditions of the atmosphere, especially during heavy wind and rain, are often very large, are corrected by the tendency of the dropping to maintain the neutral line in the one definite position. The objects to be attained by simultaneous observations in different localities alluded to were: 1. To fix the constant for any observatory, by which its observations are reduced to absolute measure of electro-motive force per foot of air. 2. To investigate the distribution of electricity in the air itself — whether on visible clouds or in clear air — by a species of electrical trigonometry, of which the general principles were slightly indicated. A portable electrometer, adapted for balloon and mountain observations, with a burning match, regulated by a spring so as to give a cone of fire in the open air, in a definite position with reference to the instrument, was exhibited. It is easily carried, with or without the aid of a shoulder-strap, and can be used by the observer standing up, and simply holding the entire apparatus in his hands, without a stand or rest of any kind. Its indications distinguish positive from negative, and are reducible to absolute measure on the spot. The author gave the result of a determination which he had made, with the assistance of Mr. Joule, on the Links, a piece of level ground near the sea, beside the city of Aberdeen, 8 A.M. on the preceding day (September 14), under a cloudless sky, and with a light northwest wind blowing, with the insulating stand of the collecting part of the apparatus buried in the ground, and the electrometer removed to a distance of five or six yards, and

connected by a fine wire with the collecting conductor. The height of the match was three feet above the ground, and the observer at the electrometer lay on the ground to render the electrical influence of his own body on the match insensible. The result showed a difference of potentials between the earth (negative) and the air (positive) at the match equal to that of one hundred and fifteen elements of Daniel's battery, and, therefore, at that time and place, the aërial electro-motive force per foot amounted to that of thirty-eight Daniel's cells.

ON THE THEORY AND CONSTRUCTION OF LIGHTNING-RODS.

The theory of a thunder-cloud and a conductor ought to be better understood in this country than it is, seeing that it lies almost in a nutshell. Lightning obeys one unvarying law,— it uniformly follows the best continuous conductor; but no conductor can be considered a good one unless it is continuous. Numerous evidences of this have been afforded by broken or otherwise defective rods. A flash takes the rod and follows it to where the break exists, then finds its next best conductor within the building, immediately opposite the spot where it discovered the break, crashes through the wall, perhaps where the family are sitting, and deals death around it, finding its way into the earth by tortuous channels, the stove-pipe, the gas-pipe, or, in their absence, by shattering the wood-work and plastering. Defective rods of any kind are mere traps to bring lightning into a house, instead of keeping it out. They are the most dangerous fixture a man can have about him; and though numerous crudely written paragraphs are constantly afloat of houses being damaged, though provided with rods, yet it may be assumed as absolutely certain that in every such instance the rod has been miserably out of order, or put up meanly and cheaply by direction of a penurious owner, or by an ignorant and incompetent peddler. The principle of protection developed by Franklin remains sound; and all that is needed to secure perfect immunity from danger is a strict adherence to what we know it demands as the condition of safety. When the usual term for thunder-storms is coming on, every careful householder should have his lightning rods examined, and, if found defective, put in perfect order. The joints should be seen to be close and tight, for continuity is indispensable to safety. If the winter's storm has bent that part which projects above the roof, it should be taken down and straightened. See, also, that the lower section which goes into the ground has not rusted off, as is often the case. And this thorough examination should be made every year.

Thunder-clouds are charged with different degrees of intensity, some heavily, some lightly. Some sweep over the earth at a greater altitude than others. Those which hang low discharge their contents, whether of water or electricity, with the greatest energy. All our thunder-storms, with few exceptions, come up from the northwest. Hence the conductors should be erected at those points of the building with which the cloud will first come in contact. This is necessary, because every thunder-cloud is surrounded by an electric atmosphere, which precedes the cloud itself. This may be easily verified by placing the knuckle to the conductor as the cloud approaches. Sparks will frequently be drawn from it while the thunder yet rolls in the distance, showing that the electrical haze has already enveloped the building, and that the rod is silently conducting the fluid into the earth. The rod is already performing its functions with the mere electrical atmos-

phere, just as it would seek to do if assailed by an explosion from the cloud. But thousands of rods have been put up by the peddlers in direct violation of this rule, even when the prominent points of the building were in the proper quarter. The gable-ends of barns most remote from the approaching cloud are selected by them as frequently as the proper end. Persons of the highest pretensions in their business of making conductors are constantly committing this grievous error. It cannot be too speedily and generally corrected. Some five years ago a young woman was picking cherries in a tree which stood near her father's house, in Warren County, New Jersey. A cloud was seen to be approaching, though at a great distance. But it was surrounded and preceded by a highly excited electrical atmosphere. There was no rain, as the cloud was a great way off. Yet persons in the neighborhood saw a flash traverse the air in an almost horizontal line, and shatter the tree in which the girl was seated, and she was killed. This was an unusual occurrence; and yet a similar discharge has been seen to leave a cloud and traverse a great distance, until it reached a stream of rarefied air, sent up from a barn but recently filled with new hay. It followed this stream as a choice conductor, struck, and destroyed the barn.

This presence of au electrical atmosphere has sometimes exhibited the most remarkable phenomena. The great lightning storm of June, 1848, was especially productive of them. Mr. Cooper's rolling-mill at Trenton, N. J., seemed to be charged in every part with electricity. Though that storm extended over a surface of seven hundred miles, yet no place witnessed a more singular display of its mighty energies than Trenton. The lightning struck the earth there repeatedly. A workman at the rolling-mill attempted to lower the iron-damper, which was connected with iron chains, but he no sooner laid his hand on the latter than he received a shock which prostrated him. A second workman repeated the attempt, and was in turn knocked down, while the third also received a severe shock. A fireman attempted to stir the melted iron in the furnace, but the instant his iron-stirrer touched the fluid metal he received a violent shock. Other similar facts occurred, showing that the whole atmosphere was charged with electricity to an extraordinary extent, and that chains, bars, furnaces, and even the melted metal, were silently acting as conductors between the cloud and the earth, giving out neither shock nor spark unless touched by the unconscious workman. The masses of metal which surrounded the three hundred hands employed in the mill were so many potent protectors. But the same precautions should be used to guard against the electrical atmosphere which invariably precedes and surrounds a thunder-cloud, as against the cloud itself.

The true position in which the rods should be affixed having been ascertained as mentioned above, the next important question is as to the quantity of iron to be used. A wire one-quarter inch thick will effectually protect any building, providing there be a point of stiff metal set up on every prominent part, with as many outlets into the ground as there are points in the air, the whole being connected by cross wires extending over the building. Galvanized wire is preferable to all others, as it is not liable to oxidation. The greater the quantity of iron, and the more numerous the outlets, the greater the safety. This is in accordance with Franklin's directions, except that the quantity of iron is increased. A large building should have some hundreds of feet of rod, and any building whatever should have not less than two points and two outlets. There is a good reason for this apparent profusion of iron. Explosions of electricity vary in intensity, some being very feeble,

while others are of awful power. No certain calculation can be made as to whether the coming shock will be light or heavy; hence it is prudent to guard against the latter, as in doing so we effectually disarm the former. A light shock will be carried off by a single rod without injury; but the discharging power of such a rod being uniform with its receiving power, because of its single outlet, an explosion on its point may occur, charged with so prodigious a volume of electricity that the capacity of the rod is not great enough to carry it off. Herein lies the great danger of an insufficient conductor. The discharging power being fixed and limited, any excess of electricity will leave the conductor, fly off into the house in search of another, whether it be the stove-pipe or the human body, and do its deadly work. Innumerable cases where such results have followed an excessive discharge on a conductor having a single outlet to the earth are on record. Accounts are often published of injury to buildings, though protected by conductors; but careful examination into the facts of the case has invariably shown that, though the conductor was free from defect, its capacity was too small to break up and carry off a heavy shock. It follows, then, that the discharging power of a conductor must be equal to its receiving power; that a building should be armed with points on all its prominent projections, because no calculations can be made on which prominence the shock may fall; that these receiving points should have numerous discharging points descending to moisture in the earth, and that the whole should be connected by wires in several directions across the roof, so that whichever point may happen to receive the shock will be aided by the entire network of metal in instantly mitigating its intensity by distributing it over a large surface, and passing it off by numerous outlets. The fluid concentrated in the shock had been previously distributed over the surface of an immense body of clouds. How unreasonable it is to expect a single discharging point to pass off the volume of electricity accumulated in so great a body of vapor. It is for these reasons that the cheap conductors are found so often mere traps, bringing the dangerous element into a building, instead of leading it away.

It is a mistake, as well as a useless expense, to put up glass insulators to prevent the lightning from leaving the rod and passing into the house. No flash will quit a properly-constructed rod, because lightning never avoids a good conducting medium to follow a bad one. Hence, the rod being continuous and the staple not so, iron staples are entirely safe. An explosion will shatter glass ones into fragments, and the sleet and ice of winter will as certainly destroy them. As few thunder-clouds pass over without discharging their watery contents, the glass insulators become wet, and while in that condition are as good conductors as the iron staples. An immense amount of humbug has been propagated among the people by ignorant peddlers, engaged in selling rods, on the necessity of glass insulators. They have introduced and sold them as indispensable to protection, either through entire ignorance of their worthlessness, or to enhance the profit on their wares. So also, with respect to gold or platinum points, costing several dollars each. These serve no other purpose but to prevent oxidation. But the point of a lightning-rod rarely or never oxidates. Its exposure to the air causes it to dry rapidly. If galvanized iron be used, as recommended for the wire, it will stand for centuries uninjured. The great object is to make every prominent part of the building bristle with points, and to supply them with an abundance of outlets to the earth, giving to the whole rod a discharging power proportioned to, or even greater than, its receiving power. —*New York Tribune.*

WAY'S NEW ELECTRIC LIGHT.

The principle of a new device for obtaining an electric light, originated by Professor Way, of London, is the application of the current of a voltaic battery to a moving column of mercury. The mercury is contained in a crystal globe of the size of an orange, whence it flows through a very minute orifice in the form of a thin metallic thread, not larger than a very small needle, to a little cup below. From this cup it falls into a basin, to be again restored to the globe or reservoir above. During its passage from the globe to the cup it comes into contact with the wires of the battery, and a vivid light is produced, ceasing whenever the contact is interrupted. The continuance of the light is regulated by a piece of clock-work machinery, carrying a revolving disc, the face of which is covered with numerous holes, with pins to fit in as may be required. In front of the disc are two small cylinders, with pistons and arms attached. As the disc revolves, the pins in its face lift the pistons in the cylinders and cut off the connection between the battery and the lighting apparatus, producing flashes of light of any duration that may be required.

A nocturnal excursion was lately made from the Isle of Wight, to test the efficiency of this light. The simple machinery was hoisted to the mast-head, and there soon shone out upon the surrounding land and water a light almost unnaturally brilliant. Osborne, the country-seat of the Queen, with its groves, and gardens, and walks, was rendered in every part distinctly visible. When at some distance out, it was found necessary to send a boat to the shore, and a little yawl pursued its way along a track of light, which made it easily seen from both the ship and the land. The success of the experiment was complete, and the large numbers who witnessed it pronounced Professor Way's invention far superior to any electric light hitherto introduced.

GASSIOT'S IMPROVEMENT IN THE ELECTRIC LIGHT.

It has long been known that, under certain circumstances, the electric discharge from a voltaic battery can be made to traverse short distances across air in the form of an intensely luminous, but, at the same time, intensely hot spark. If this discharge is made to pass through a glass tube, by means of platinum wires sealed into the extremities, — the air having previously been exhausted from it by means of an air-pump, — the discharge assumes an entirely different aspect. Instead of appearing in the form of disconnected sparks, the electric fluid traverses it like a continuous stream of nebulous light, filling the tube with a beautiful phosphorescent glow, whilst the heat almost disappears; on this account it was until very recently considered that electricity passed through a vacuum. Recent researches have, however, shown that a vacuum really is a non-conductor to the passage of the electric fluid, and that the phenomenon of conduction apparent in the "vacuum tube" was really due to the great conducting power possessed by a highly rarefied gas. As soon as this was known, it became a matter of great interest to electricians to ascertain the various effects which would be produced by having the tube filled with various sorts of gases, and also what difference was caused by alterations in the size and shape of the vacuum tubes employed.

The subject was especially investigated by Mr. Gassiot, the well-known

English physicist, and the result of his researches has been the discovery of a ready and simple means of applying the electric discharge from the induction coil to the purposes of illumination. A carbonic acid vacuum tube (that is, a tube filled with carbonic acid, which is then exhausted from it by means of an air-pump, until there is only the most infinitesimal trace of gas remaining), having an internal diameter of about one-sixteenth of an inch, is wound in the form of a flattened spiral; to the ends of the tube are attached two wider tubes into which platinum wires are sealed; they are inclosed in a wooden case, so as to permit only the spiral to be exposed. When the discharge from a Ruhmkorff's induction apparatus is passed through the vacuum tube, the spiral becomes intensely luminous, exhibiting a brilliant white light. M. Gassiot, who exhibited the instrument in action at a recent meeting of the Royal Society, caused the discharge to pass through two miles of copper wire, showing that it would be applicable to illumination at a distance. The results were brilliant in the extreme; and it was confidently predicted that the new device would shortly constitute one of the most useful and popular forms of the electric light.

ON THE USE OF THE ELECTRIC LIGHT FOR LIGHTHOUSE ILLUMINATION.

The following is an abstract of a lecture on the above subject by Professor Faraday, recently delivered before the Royal Institution, London:

The use of light to guide the mariner as he approaches land, or passes through intricate channels, has, with the advance of society and its ever increasing interests, caused such a necessity for means more and more perfect, as to tax to the utmost the powers both of the philosopher and the practical man, in the development of the principles concerned, and their efficient application. Formerly the means were simple enough; and if the light of a lantern or torch was not sufficient to point out a position, a fire had to be made in its place. As the system became developed, it soon appeared that power could be obtained, not merely by increasing the light, but by directing the issuing rays; and this was, in many cases, a more powerful and useful means than enlarging the combustion, leading to the diminution of the volume of the former, with, at the same time, an increase in its intensity. Direction was obtained, either by the use of lenses dependent altogether upon refraction, or of reflectors dependent upon metallic reflection; and some ancient specimens of both were shown. In modern times the principle of total reflection has also been employed, which involves the use of glass, and depends both upon refraction and reflection. In all these appliances much light is lost. If metal be used for reflection, a certain proportion is absorbed by the face of the metal; if glass be used for refraction, light is lost at all the surfaces where the ray passes between the air and the glass; and also in some degree by absorption in the body of the glass itself. There is, of course, no power of actually increasing the whole amount of light, by any optical arrangement associated with it.

The light which issues forth into space must have a certain amount of divergence. The divergence in the vertical direction must be enough to cover the sea from the horizon to within a certain moderate distance from the shore, so that all ships within that distance may have a view of their luminous guide. If it have less, it may escape observation where it ought to be seen; if it have more, light is thrown away which ought to be directed within

the useful degree of divergence; or if the horizontal divergence be considered, it may be necessary so to construct the optical apparatus, that the light within an angle of sixty or forty-five degrees shall be compressed into a beam diverging only fifteen degrees, that it may give in the distance a bright flash having a certain duration instead of a continuous light; or into one diverging only five or six degrees, which, though of far shorter duration, has greatly increased intensity and penetrating power in hazy weather. The amount of divergence depends in a large degree upon the bulk of the source of light, and cannot be made less than a certain amount, with a flame of a given size. If the flame of an argand lamp, seven-eighths of an inch wide and one and a half inches high, be placed in the focus of an ordinary Trinity House parabolic reflector, it will supply a beam having about fifteen degrees divergence. If we wish to increase the effect of brightness, we cannot properly do it by enlarging the lamp flame; for though lamps are made for the dioptric arrangement of Fresnel, which have as many as four wicks, flames three and a half inches wide, and burn like intense furnaces, yet if one be put into the lamp place of the reflector referred to, its effect would chiefly be to give a beam of wider divergence; and if, to correct this, the reflector were made with a greater focal distance, then it must be altogether of a much larger size. The same general result occurs with the dioptric apparatus; and here, where the four-wicked lamps are used, they are placed at times nearly forty inches distant from the lens, occasioning the necessity of a very large, though very fine, glass apparatus.

On the other hand, if the light could be compressed, the necessity for such large apparatus would cease, and it might be reduced from the size of a room to the size of a hat; and here it is that we seek in the electric spark, and such like concentrated sources of light, for aid in illumination. It is very true that by adding lamp to lamp, each with its reflector upon one face or direction, power can be gained; and in some of the revolving lights ten lamps and reflectors unite to give the required flash. But then not more than three of these faces can be placed in the whole circle; and if a fixed light be required in all directions round the lighthouse, nothing better has been yet established than the four-wicked Fresnel lamp in the centre of its dioptric and catadioptric apparatus. Now the electric light can be raised up easily to an equality with the oil lamp, and if then substituted for the latter, will give all the effect of the latter; or, by expenditure of money, it can be raised to a five or tenfold power, or more, and will then give five or ten-fold effect. This can be done not merely without increase of the volume of the light, but whilst the light shall have a volume scarcely the two-thousandth part of that of the oil flame. Hence the extraordinary assistance we may expect to obtain of diminishing the size of the optical apparatus and perfecting that part of it.

Many compressed intense lights have been submitted to the Trinity House; and that corporation has shown its great desire to advance all such objects, and improve the lighting of the coast, by spending, upon various occasions, much money and much time for this end. It is manifest that the use of a lighthouse must be never-failing, its service ever sure; and that the latter cannot be interfered with by the introduction of any plan, or proposition, or apparatus, which has not been developed to the fullest possible extent, as to the amount of light produced, the expense of such light, the wear and tear of the apparatus employed, the steadiness of the light for sixteen hours, its liability to extinction, the amount of necessary night care, the number of

attendants, the nature of probable accidents, its fitness for secluded places, and other contingent circumstances, which can as well be ascertained out of a lighthouse as in it. The electric spark which has been placed in the South Foreland High Light, by Professor Holmes, to do duty for the six winter months, had to go through all this preparatory education before it could be allowed this practical trial. It is not obtained from frictional electricity, or from voltaic electricity, but from magnetic action. The first spark—and even magnetic electricity as a whole—was obtained twenty-eight years ago. (Faraday, *Philosophical Transactions*, 1832, p. 32.) If an iron core be surrounded by wire, and then moved in the right direction near the poles of a magnet, a current of electricity passes, or tends to pass, through it. Many powerful magnets are therefore arranged on a wheel, that they may be associated very near to another wheel, on which are fixed many helices with their cores like that described. Again: A third wheel consists of magnets arranged like the first; next to this is another wheel of the helices, and next to this again a fifth wheel carrying magnets. All the magnet wheels are fixed to one axle, and all the helix wheels are held immovable in their place. The wires of the helices are conjoined and connected with a commutator, which, as the magnet wheels are moved round, gathers the various electric currents produced in the helices, and sends them up through two insulated wires in one common stream of electricity into the lighthouse lantern. So it will be seen that nothing more is required to produce the electricity than to revolve the magnet wheels. There are two magneto-electric machines at the South Foreland, each being put in motion by a two-horse power steam-engine; and, excepting wear and tear, the whole consumption of material to produce the light is the coke and water required to raise steam for the engines and carbon points for the lamp in the lantern. The lamp is a delicate arrangement of machinery, holding the two carbons between which the electric light exists, and regulating their adjustment; so that whilst they gradually consume away, the place of the light shall not be altered. The electric wires end in the two bars of a small railway, and upon these the lamp stands. When the carbons of a lamp are nearly gone, that lamp is lifted off and another instantly pushed into its place. The machines and lamp have done their duty during the past six months in a real and practical manner. The light has never gone out through any deficiency or cause in the engine and machine house, and when it has become extinguished in the lantern, a single touch of the keeper's hand has set it shining as bright as ever. The light shone up and down the Channel, and across into France, with a power far surpassing that of any other fixed light within sight or anywhere existent.

To show the necessity for an intense light in lighthouse illumination, Dr. Faraday reminded his audience of the dark shadow thrown by the steam issuing from a railway locomotive on a sunshiny day; and, having cast a concentrated light from the electric lamp upon a screen, he showed how instantaneously it was darkened by an artificial cloud made of high pressure steam, and which might be taken as an illustration of the effect of the sea fogs and mists so common near the coast.

ELECTRIC LIGHT TELEGRAPH.

Mr. Caselli purposes to employ the electric light for telegraphic purposes during war, or in situations that do not admit of the usual communication by wire. Signals like those of Morse would be represented by two lengths

of light, one long and the other short, and by eclipses of three lengths or durations. He proposes to obtain the light either from a Bünsen battery of fifty elements, or from a magneto-electrical machine, and gives a preference to the latter, as the charcoal points are equally consumed, which is of consequence when a lens is employed to concentrate the rays.

VELOCITY OF ELECTRICITY.

M. M. Guillemin and Burnouf, of France, have recently instituted an extensive series of experiments on the transmission of electricity by telegraphic wires, with a view of discovering some law which governs its transmission. They conclude from their researches that the electric fluid is not propagated like the waves or undulations of light, and that it has not a constant and uniform velocity. They find it necessary to fall back upon the idea of Ohm, expressed in 1827, that electricity is propagated through wires, in virtue of the same kind of laws which govern the propagation of heat in a metallic bar. To determine experimentally which of these two opinions ought to prevail, — that is, whether electricity is propagated with a constant and uniform velocity, or whether it is transmitted like heat, — the authors disposed an apparatus, showing the intensity of the electric current in a certain point of a conducting wire, at different instants of its propagation. The first or the second opinion would then be justified, according as the current acquired suddenly in this point its definite intensity, or arrived at this intensity gradually. The authors found that the current at the point in question began with a very feeble intensity (the galvanometer marking 0° 50′), which augmented gradually, and soon attained a maximum, which it did not surpass, however long the contact of the pile with the conducting wire was continued. This maximum or permanent state was obtained in 0·024 of a second of time (the galvanometer then marking 19° 50′), in four lines of different lengths. The experiments were made during very fine weather, from 10 to 12 o'clock at night, from the 4th to the 6th of October, 1859, on a telegraph circuit of 104 leagues in length, passing from Nancy to Strasbourg, Mulhouse and Vesul, back to Nancy.

ANALYSIS OF INDUCTION SPARKS.

M. Moncel, of France, affirms, as the result of his experiments, that the induced spark is not homogeneous, but consists of the original discharge, and of a secondary discharge through a luminous atmosphere, which is generated by the heating and rarefication of the adjacent air. He also states that the discharge through this luminous atmosphere exhibits the most striking calorific effects; while the original discharge possesses the properties of frictional electricity. By employing a microscope to examine the induction spark, he satisfied himself that the luminous atmosphere was only a miniature representation of the induction light seen in a vacuum; continuing his investigations, he succeeded in detecting in the luminous atmosphere which accompanies the spark when the discharge takes place in common air, the stratifications which are so remarkable in the hydrogen vacuum. In this experiment he caused the discharge to traverse the flame of a wax candle, when the light of the negative pole, instead of being blue, as in the hydrogen vacuum, was a brilliant white, owing to the presence of carbonaceous particles. When one of the rheophores is plunged into water,

and the discharge taken through the fluid, some curious effects take place, modified according to which pole is immersed, but in each case the luminous atmosphere exhibits singular corruscations. When the rheophores are separated, so that the direct discharge cannot take place, the effects of the luminous atmosphere are still more conspicuous.

ELECTRICAL ACTION OF THE TORPEDO.

From the results of some experiments recently published by M. Matteucci, we learn that the electro-motive power of the organ of the torpedo exists independently of the immediate action of the nervous system. If a section of the electric organ of the torpedo which has been dead forty-eight hours, or if the torpedo be exposed for the same number of hours to the action of the open air, or left for twenty-four hours in a frigorific mixture, where it may have hardened or become frozen, or if kept during the latter period in water at a temperature from 104° to 122°, be made to communicate with a galvanometer, a great deviation will be produced. If the torpedo be killed with the poison curare or woorali, it will present the same electro-motive power as if it had died naturally. In its operations as a nerve-discharging battery, its electro-motive power is considerably increased under stimulated action. When the nerves of the organs have been several times excited in succession, that power for which the torpedo is so remarkable is greatly increased, and will produce a greater number of discharges than it would in its normal condition. For instance: — Let two pieces of equal dimensions, each containing a strong nervous filament, be prepared of one of the organs of a torpedo; let them be placed on a piece of gutta-percha, with the two nerves opposite to each other, and situated perpendicularly to the prisms of a thermo-electric apparatus; on closing the circuit of the galvanometer, a small differential current becomes apparent, but soon disappears. Then if the nerve of a galvanoscopic frog be placed upon each organ, and the circuit be broken under a mercury bath while the nerve of one of the pieces is being irritated with the points of a fine pair of scissors, the frog then in contact with that piece will exhibit violent convulsions. When after this the nerve is left at rest, and the circuit of the galvanometer again closed, a strong deviation, which lasts a long time, is perceived in the direction of the excited organ. The electro-motive power of the organ of a torpedo is not influenced by the nature of any gaseous medium in which it may be left for twenty-four hours. This is proved by comparing, in opposition to each other, two pieces preserved in different gases, such as hydrogen, oxygen, carbonic acid, and atmospheric air more or less rarefied; when it will appear that there is no constant difference between the electro-motive powers of the two pieces.

WEAVING BY ELECTRO-MAGNETISM.

In the improvement of the old weaving machine, effected by Jacquard, under the encouragement of the first Napoleon, the pattern of the design was pricked on large perforated cards, which went in an endless chain round a roller in the centre of the loom. All the threads of the warp were connected with bars in the upper part of the loom, and these, by a movement of the weaver's treadle, were pushed against the perforated cards. Those which faced the pattern holes, and therefore corresponded with them, remained there, and so, when the lever was lowered, held up the threads which ought

to have been raised, and allowed the shuttle to weave in the weft or pattern between.

This machine was an immense improvement on the old affair; yet, though always continuing the best, it had its own peculiar drawbacks. Thus, a pattern for a damask curtain or tablecloth, of a rich or elaborate design, we will say, required from twenty thousand to twenty-five thousand cards. To produce these occupied men from two to four, six, or even eight months, according to the greater or less intricacy of the design, and cost from six hundred to nine hundred dollars. As a matter of course, therefore, designs were made as simple and plain as possible, were not often changed, and never until the trade would no longer take them.

M. Bonelli at once sets aside all this by the use of electricity. The little bobbins or bars which hold up the threads of the warp in the Jacquard loom he makes into electro-magnets in the usual way. The design is painted on a sheet of tinfoil, with the portions not used in the pattern covered with a non-conducting varnish. The pattern passes slowly over a roller under an immense number of brass teeth, communicating by fine insulated wires with the bobbins, the pattern of course being in connection with one pole of the battery, and the bobbins, or magnets, with the other. Thus, as the tinfoil slowly moves round, the parts which are not to be worked, being covered with a non-conducting varnish, transmit no current through the brass teeth to the bobbins. The pattern, or exposed portion of the tinfoil, on the contrary, does so, and transforms the bobbins into electro-magnets, which attract and hold the bars opposite their points attached to the threads of the warp, and these bars being thus held up for an instant, of course raise the threads of the warp below, and allow the shuttle to weave in a particular pattern.

This is merely a very rough and general outline of the old and new plans. The latter, however, is far too important to be thus disposed of in a few words. What we have already said will, nevertheless, assist our readers to comprehend the details of this most valuable improvement. The electric loom, as it is termed, was invented in 1854, by the Chevalier Bonelli, of Milan, and director of the Sardinian telegraphs. The first machine, constructed at Turin, was afterwards modified by M. Hipp, at Berne; and though it demonstrated the possibility of weaving by means of electro-magnetism, it nevertheless left much to be desired with respect to the success of its practical application. It was not until 1859 that success in perfecting the machinery, and in rendering it available for either hand or power-loom weaving, was attained. To fully appreciate all the advantages which this application of electricity to the manufacture of woven material must produce, it is necessary always to keep in mind the long and costly operations which, as we have said, are now incurred before commencing weaving in one or two colors.

Firstly, then, in weaving by the old machine, we must remember the design is drawn on paper divided into a multitude of little squares, the horizontal series representing the weft, or pattern; the cross, or short series, the warp, or substance of the material woven. Secondly, the design must be "read;" that is, the punches of the stamping machine, which are equal in number to the small squares of the pattern, must be arranged so as to perforate the cards, which, as we have shown, form the basis of the present Jacquard system. Each of these operations must be repeated as many times as there are horizontal lines in the design, — which merely represents one thread of

the weft, — as there must be as many cards as there are wefts or cross-threads in a pattern. Lastly, all the cards must be sewn together in the order of their succession. We have already shown how in the "Jacquard" these pierced cards act on the pins of the loom, and determine the raising of the threads of the warp or basis of the material beneath. M. Bonelli's looms instantly accomplish all this work we have been describing, with an exactitude that could never be obtained from "the cards," which, as our readers will easily understand, were almost incapable of producing a very complex pattern. It is by passing the thread of the weft over or under the thread of the warp that the design, either in one or many colors, is produced. The design in M. Bonelli's plan is traced on a sheet of tinfoil, the pattern remaining in bright metal, while all the rest is painted over with a non-conducting varnish. The metal pattern thus becomes the conductor of the electricity; the varnished portions do not. This thin sheet of tinfoil is placed on a roller, which revolves it by very slow degrees, with a uniform movement, under a metallic comb. This comb contains teeth equal in number to the pins of a Jacquard loom, — from four hundred to six hundred, — each of which is most carefully insulated from the next, and each connected by a fine wire with a small electro-magnet or bobbin. A wire from a small Bunsen pile is connected with this comb and electro-magnets, the other wire with the tinfoil design. When by the ordinary movement of the Jacquard loom, effected by the foot of the workman pressing the treadles, the loom moves, the metallic comb lowers itself, and comes in contact with the tinfoil sheet of the design. The teeth of the comb touching on the varnished portions, of course, stop the passage of an electric current to the bars with which they communicate, and which, in fact, therefore remain mere bobbins. All those, on the contrary, which touch the metallic parts of the sheet — the design, in fact — allow the current to pass to the electro-magnets, which instantly become active, and capable of attracting little horizontal bars of iron, which are arranged with their points towards the magnets in a frame common to them all. Those magnets, therefore, which are active, at once attract and retain the bars as the frame, all by a simple movement, in a second, moves a little back and lowers, and thus the threads of the warp below, which are attached to crochet-needles hanging on to the magnetized bars, are raised, and the shuttle with the weft of the pattern-thread passes in between them.

There is a little mechanical contrivance employed to give solidity to the arrangement of the bars, — a solidity which is necessary, as the magnetized bars have to act upon the needles of the loom, and keep them and their threads suspended. Such are the chief features of this electro-magnetic weaving machine, which, apart from its scientific merits, contains, in addition, some most admirable mechanical contrivances. Such, for instance, is the ingenious means by which the design-sheet moves with a speed variable at will, and either backwards or forwards, and the addition of a little brush to clean the comb. This last, at each motion of the loom, sweeps across all its teeth, to prevent the injurious action of the dust, which, falling upon the surface, would soon interfere with the action of the electric fluid. The loom which we have now described is only applicable to stuffs of two colors; that is to say, of one color upon one general ground. But a loom capable of weaving stuffs of six, eight, or ten colors, only differs by the addition of a most simple piece of mechanism, thus: Each of the different colors is insulated from the other, and along them, on the pattern, the pole of the bat-

tery slowly passes as the weaver works the machine with his feet, transmitting the current to each color in the order in which they occur.

Thus, of course, the current is sent through the comb to the electro-magnets, which raise the thread of the warp below, where the weaver has his color-shuttles arranged in the order in which they are to be used, and throws them in accordingly. So the loom just as easily, and on the same principle, transmits the pattern to a stuff of twelve colors as to that of only two. It is in this that the weaving by electricity displays its superiority over the present system, according to which, for example, if a material is to be worked in six colors, it is necessary by the Jacquard loom to employ six times more cards than for a similar design of one color. The advantages, therefore, which ought to result from the introduction of the electro-magnetic loom in the manufacture of all our patterned fabrics are sufficiently apparent. A new method, which does away with all the operations necessary to the preparation of the cards, must, of course, produce an all-important saving of both time and money upon the present system of manufacture. But there are other and not unimportant advantages, such, for instance, as permitting all manufacturers to try the effect of new patterns without going through the long and costly process of preparing cards. He can ascertain in a few hours the effect of any design, and prepare a series of specimens for the approbation of the trade before commencing upon a single yard of stuff. In short, whatever can be done by printing, lithographing, or engraving, can be thus stamped on tinfoil, and reproduced in colored silks, according to the colors of the original, with all the fidelity of an electrotype.

By this means, at a trifling cost, families can have special designs, such as crests and initials, for carpeting, curtains, furniture covers, etc., at a week's notice. In this loom also the workman is enabled, with the greatest facility, to effect a reduction of the design, by means of varying the speed of the cylinder on which the pattern is placed. Without alteration, or without touching the design, it can with equal facility make stuffs more or less strong or more or less light, by changing the number of the threads of the weft, and by regulating, in accordance with that change, the speed of the cylinder on which the pattern revolves. Of course, any required additional effect can be made, or any part omitted from the design, without at all interfering with the workman. As a matter of course, the electrical portions of the invention are capable of application to any loom, and, in fact, occupy, at the top of the machine, no more space than a small writing-desk. It is only the cards and cumbrous accessories of the Jacquard loom which are done away with; its mechanical properties are retained, and the electro-magnets can be applied to any. It is expected that with this machine, in all very large or intricate patterns, such as are now occasionally used in silks, a saving of eighty per cent in money, and more than eighty per cent in time, will be gained upon the production of similar designs by the present system.

ON THE INFLUENCE OF MAGNETIC FORCE ON THE ELECTRIC DISCHARGE.

The following is an abstract of a lecture recently delivered before the Royal Institution, Great Britain, by Professor Tyndall, which was intended to illustrate the constitution of the electric discharge, and of the action of magnetism upon it: —

1. The influence of the transport of particles was first shown by an experi-

ment suggested, it was believed, by Sir John Herschel, and performed by Professor Daniell. The carbon terminals of a battery of forty cells of Grove were brought within one-eighth of an inch of each other, and the spark from a Leyden jar was sent across this space. This spark bridged with carbon particles the gap which had previously existed in the circuit, and the brilliant electric light due to the passage of the battery current was immediately displayed.

2. The magnified image of the coal points of an electric lamp was projected upon a white screen, and the distance to which they could be drawn apart without interrupting the current was noted. A button of pure silver was then introduced in place of the positive carbon, a luminous discharge four or five times the length of the former being thus obtained. The silver was first observed to glow, and afterwards to pass into a state of violent ebullition. A narrow dark space was observed to surround one of the poles, corresponding probably with the dark space observed in the discharge of Ruhmkorff's coil through rarefied media.

3. The action of a magnet upon the splendid stream of green light obtained in the foregoing experiment was exhibited. A small horseshoe magnet of Logemann was caused to approach the light, which was bent hither and thither, according as the poles of the magnet changed their position: the discharge in some cases formed a magnificent green bow, which on the further approach of the magnet was torn asunder, and the passage of the current thereby interrupted. It was Davy who first showed the action of a magnet upon the voltaic arc. The transport of matter by the current was further illustrated by a series of deposits on glass obtained by Mr. Gassiot from the continued discharge of an induction coil.

4. A discharge from Ruhmkorff's coil was sent through an attenuated medium and the glow which surrounded the negative electrode was referred to. One of the most remarkable effects hitherto observed was that of a magnet upon this negative light. Plücker had shown that it arranges itself under the influence of the magnet exactly in the direction of the magnetic curves. Iron-filings strewn in space, and withdrawn from the action of gravity, would arrange themselves around a magnet exactly in the manner of the negative light. An electric lamp was placed upon its back; a horseshoe magnet was placed horizontally over its lens, and on the magnet a plate of glass: a mirror inclined at an angle of 45° received the beam from the lamp, and projected it upon the screen. Iron-filings were scattered on the glass, and the magnetic curves thus illuminated were magnified, and brought to clear definition upon the screen. The negative light above referred to arranges itself, according to Plücker, in a similar manner.

5. The rotation of an electric current round the pole of a magnet, discovered by Mr. Faraday in the Royal Institution, nearly forty years ago, was next shown; and the rotation of a luminous current from an induction coil in an exhausted receiver, by the same magnet, was also exhibited, and both shown to obey the same laws.

6. Into a circuit of twenty cells a large coil of copper wire was introduced, and when the current was interrupted, a bright spark, due to the passage of the extra current, was obtained. The brightness and loudness of the spark were augmented when a core of soft iron was placed within the coil. The disruption of the current took place between the poles of an electro-magnet; and when the latter was excited, an extraordinary augmentation of the loudness of the spark was noticed. This effect was first obtained by Page, and

was for a time thought to denote a new property of the electric current. But Rijke had shown in a paper, the interest of which is by no means lessened by the modesty with which it is written, that the effect observed by Page is due to the sudden extinction of the primary spark by the magnet; which suddenness concentrates the entire force of the extra current into a moment of time. Speaking figuratively, it was the concentration of what, under ordinary circumstances, is a mere push, into a sudden kick of projectile energy.

7. The contact-breaker of an induction coil was removed, and a current from five cells was sent through the primary wire. The terminals of the secondary wire being brought very close to each other, when the primary was broken by the hand, a minute spark passed between the terminals of the secondary. When the disruption of the primary was effected between the poles of an excited electro-magnet, the small spark was greatly augmented in brilliancy. The terminals were next drawn nearly an inch apart. When the primary was broken between the excited magnetic poles, the spark from the secondary jumped across this interval, whereas it was incompetent to cross one-fourth of the space when the magnet was not excited. This result was also obtained by Rijke; who rightly showed, that in this case also the augmented energy of the secondary current was due to the augmented speed of extinction of the primary spark between the excited poles. This experiment illustrated in a most forcible manner the important influence which the mode of breaking contact may have upon the efficacy of an induction coil. The splendid effects obtained from the discharge of Ruhmkorff's coil through exhausted tubes were next referred to. The presence of the coil had complicated the theoretic views of philosophers, with regard to the origin of those effects; the intermittent action of the contact-breaker, the primary and secondary currents, and their mutual reactions, producing tertiary and other currents of a higher order, had been more or less invoked by theorists, to account for the effects observed. Mr. Gassiot was the first to urge, with a water battery of three thousand five hundred cells, a voltaic spark across a space of air, before bringing the electrodes into contact; with the self-same battery he had obtained discharges through exhausted tubes, which exhibited all the phenomena hitherto observed with the induction coil. He thus swept away a host of unnecessary complications which had entered into the speculations of theorists upon this subject.

8. On the present occasion, through the kindness of Mr. Gassiot, the speaker was enabled to illustrate the subject by means of a battery of four hundred of Grove's cells. The tension at the ends of the battery was first shown by an ordinary gold-leaf electroscope; one end of the battery being insulated, a wire from the other end was connected with the electroscope; the leaves diverged; on now connecting the other end of the battery with the earth, the tension of the end connected with the electrometer rose, according to a well-known law, and the divergence was greatly augmented.

9. A large receiver, in which a vacuum had been obtained by filling it with carbonic acid gas, exhausting it, and permitting the residue to be absorbed by caustic potash, was placed equatorially between the poles of the large electro-magnet. The jar was about six inches wide, and the distance between its electrodes was ten inches. The negative electrode consisted of a copper disk, four inches in diameter; the positive one was a brass wire. An accident had recently occurred to this jar. Mr. Faraday, Mr. Gassiot, and the speaker had been observing the discharge of the nitric acid battery

through it. Stratified discharges passed when the ends of the battery were connected with the electrodes of the receiver; and on one occasion the discharge exhibited an extraordinary effulgence; the positive wire emitted light of dazzling brightness, and finally gave evidence of fusion. On interrupting the circuit, the positive wire was found to be shortened about half an inch, its metal having been scattered by the discharge over the interior surface of the tube.

10. The receiver in this condition was placed before the audience, in the position mentioned above. When the ends of the four-hundred-cell battery were connected with the wires of the receiver, *no discharge passed;* but on touching momentarily with the finger any portion of the wire between the positive electrode of the receiver and the positive pole of the battery, a brilliant discharge instantly passed, and continued as long as the connection with the battery was maintained. This experiment was several times repeated: the connection with the ends of the battery was not sufficient to produce the discharge, but in all cases the touching of the positive wire caused the discharge to flash through the receiver. Previous to the fusion of the wire above referred to, this discharge usually exhibited fine stratification: its general character now was that of a steady glow, through which, however, intermittent luminous gushes took place, each of which presented the stratified appearance.

11. On exciting the magnet between whose poles the receiver was placed, the steady glow curved up or down, according to the polarity of the magnet, and resolved itself into a series of effulgent transverse bars of light. These appeared to travel from the positive wire along the surface of the jar. The deflected luminous current was finally extinguished by the action of the magnet.

12. When the circuit of the magnet was made and immediately interrupted, the appearance of the discharge was extremely singular. At first the strata rushed from the positive electrode along the upper surface of the jar, then stopped, and appeared to return upon their former track, and pass uccessively with a deliberate motion into the positive electrode. They were erfectly detached from each other; and their successive ingulfments at he positive electrode were so slow as to be capable of being counted aloud vith the greatest ease. This deliberate retreat of the strata towards the ositive pole was due, no doubt, to the gradual subsidence of the power of the magnet. Artificial means might probably be devised to render the recession of the discharge still slower. The rise of power in the magnet was also beautifully indicated by the deportment of the current. After the current had been once quenched, as long as the magnet remained excited no discharge passed; but on breaking the magnet circuit, the luminous glow reappeared. Not only, then, is there an action of the magnet upon the particles transported by an electric current, but the above experiment indicates that there is an action of the magnet upon the electrodes themselves, which actually prevents the escape of their particles. The influence of the magnet upon the electrode would thus appear to be *prior* to the passage of the current.

13. The discharge of the battery was finally sent through a tube, whose platinum wires were terminated by two small balls of carbon: a glow was first produced; but on heating a portion of the tube containing a stick of caustic potash, the positive ball sent out a luminous protrusion, which sub-

sequently detached itself from the ball; the tube becoming instantly afterwards filled with the most brilliant strata.

There can be no doubt that the superior effulgence of the bands obtained with this tube is due to the character of its electrodes; *the bands are the transported matter of these electrodes.* May not this be the case with other electrodes? There appears to be no uniform flow in nature; we cannot get either air or water through an orifice in a uniform stream; the friction against the orifice is overcome by starts, and the jet issues in pulsations. Let a lighted candle be quickly passed through the air; the flame will break itself into a beaded line in virtue of a similar intermittent action, and it may be made to sing, so regular are the pulses produced by its passage. Analogy might lead us to suppose that the electricity overcomes the resistance at the surface of its electrode in a similar manner, escaping from it in tremors; the matter which it carries along with it being broken up into strata, as liquid vein is broken into drops.

ON THE ORIGIN OF ATMOSPHERIC ELECTRICITY.

It is well known that the earth is, relatively to the air, negatively electrified. If a bar of polished metal be held horizontally, no electrical phenomena are manifested, but when it is turned to a vertical direction at once the lower extremity becomes positively electrified, and the upper negatively. This takes place evidently by induction. So in a thunder-storm. The air at the surface, becoming abnormally heated and moist, comes to be in a state of tottering equilibrium, in which state the slightest disturbance will throw it rolling over and over, and, rising into colder regions, it condenses and falls as rain. The rising column, like the bar before mentioned, becomes at bottom charged with positive electricity, and at the top with negative; and the thunder-cloud becomes, in fact, two, one above the other, which Mr. Wise, the aeronaut, has often seen and described. Between these, filled with opposite electricities, a gigantic spark passes, which is the forked lightning. Thus the conclusion is that atmospheric electricity is due to induction from the earth. — *Prof. Henry.*

NEW SECONDARY PILE OF GREAT POWER.—BY M. G. PLANTÉ.

Jacobi proposed recently the use of secondary electric currents for telegraphic purposes, and Planté had suggested the substitution of electrodes of lead for those of platinum in these batteries. A more extended study has convinced him of their use. He states that a battery with electrodes of lead has two and a half times the electro-motive force of one with electrodes of platinized platinum, and six times as great as that of one with ordinary platinum. This great power arises from the powerful affinity which peroxide of lead has for hydrogen, a fact first noticed by De la Rive. The secondary battery which he recommends has the following construction: It consists of nine elements, presenting a total surface of ten square metres. Each element is formed of two large lead plates, rolled into a spiral, and separated by coarse cloth, and immersed in water acidulated with one-tenth sulphuric acid. The kind of current used to excite this battery depends on the manner in which the secondary couples are arranged. If they are arranged so as to give three elements of triple surface, five small Bunsen's cells, the zincs of which are immersed to a depth of seven centimetres, are sufficient

to give, after a few minutes' action, a spark of extraordinary intensity when the current is closed. The apparatus plays, in fact, just the part of a condenser; for by its means the work performed by a battery, after the lapse of a certain time, may be collected in an instant. An idea of the intensity of the charge will be obtained by remembering that to produce a similar effect it would be necessary to arrange three hundred Bunsen's elements of the ordinary size (thirteen centimetres in height), so as to form four or five elements of three and a half square metres of surface, or three elements of still greater surface. If the secondary battery be arranged for intensity, the principal battery should be formed of a number of elements sufficient to overcome the inverse electro-motive force developed. For nine secondary elements, about fifteen Bunsen's cells should be taken, which might, however, be very small.

From the malleability of the metal of which it is formed, this battery is readily constructed; by taking the plates of lead sufficiently thin, a large surface may be placed in a small space. The nine elements used by Planté are placed in a box thirty-six centimetres square, filled with liquid once for all, and placed in closed jars; they may also be kept charged in a physical cabinet, and ready to be used whenever it is desired to procure, by means of a weak battery, powerful discharges of dynamic electricity. —*Comptes Rendus, March 26th*, 1860.

EFFECT OF PRESSURE ON ELECTRO-CONDUCTING POWER.

M. Elie Wartmann has found experimentally that the electric conductibility of copper wire is sensibly diminished by a pressure of fifty atmospheres, that this diminution increases with the pressure, and disappears when the pressure is relieved. The experiments were carried up to four hundred atmospheres. These results establish a new analogy between heat, light, and electricity. —*L'Institut.*

ON THE TRANSMISSION OF ELECTRIC EFFECTS ACROSS WATER WITHOUT THE AID OF TRANSVERSE WIRES.

At the Aberdeen meeting of the British Association, 1859, Mr. Lindsay, of Dundee, stated that he commenced experimenting in 1844 in telegraphing across water, without wires first, and then by means of two uninsulated wires; and finding the latter method much more powerful, he preferred it, and telegraphed in that way through several ponds in Dundee. In 1852 he resumed experiments without transverse wires. In 1853 he made experiments on a larger scale at Portsmouth, and succeeded in crossing more than a quarter of a mile. More recently he had made additional experiments, and succeeded in crossing the Tay where it was three-quarters of a mile broad. His method had always been to immerse two plates or sheets of metal on the one side, and connect them by a wire passing through a coil to move a needle, and to have on the other side two sheets similarly connected, and nearly opposite the two former. Experiments had shown that only a fractional part of the electricity generated goes across, and that the quantity that thus goes across can be increassed in four ways: first, by an increase of battery power; second, by increasing the surface of the immersed sheet; third, by increasing the coil that moves the receiving needle; and fourth, by increasing the lateral distance. In cases where lateral distance could be got, he recom-

mended increasing it, as by that means a smaller battery was requisite. In telegraphs by this method to Ireland or France, abundance of lateral distance could be got; but for America the lateral distance in Britain was much less than the distance across. In the greater part of his experiments the distance at the side had been double the distance across; but in the experiment across the Tay the lateral distance was the smaller, being only about half a mile, while the distance across was three-quarters of a mile. Of the four elements above mentioned, he thought that if any one were doubled, the quantity of electricity that crossed would also be doubled; and if all the elements were doubled, the quantity transmitted would be eight times as great. In the experiment across the Tay the battery-power was of four square feet of zinc; the immersed sheets contained about ninety square feet; the weight of the copper coil was about six pounds; the lateral distance was less than the transverse distance, but if it had been a mile, and the distance across also a mile, the signal would no doubt have been equally distinct. Should the above law (when the lateral distance is equal to the transverse) be found correct, the following table might thus be formed:—

Zinc for battery. Square feet.	Immersed sheets. Square feet.	Coil. Pounds.	Distance crossed. Miles.
4	90	6	1
8	180	12	8
16	360	24	64
32	720	48	512
64	1440	96	4096
128	2880	192	32,768

But supposing the lateral distance to be only half the transverse, then the distance crossed might be sixteen thousand miles; and if it was only a fourth, then there would be eight thousand miles, and thus a greater distance than the breadth of the Atlantic. Further experiments were, however, necessary to determine the law. On the battery side he had made the electricity pass through a coil of thick wire, and on the receiving side through one of small wire; and when a battery and receiver were on each side, by means of a shifter of communication, the path for sending was through the thick wire, and for receiving through the small. Since this last experiment he had increased the coil, and thought there was power to transmit signals for two miles. According to this calculation, he thought a battery of one hundred and thirty square feet, immersed sheets of three thousand square feet, a coil of two hundred pounds weight, were sufficient to cross the Atlantic, with the lateral distance that could be obtained in Great Britain.

In the course of the discussion Sir D. Brewster said that he was a member of the committee entrusted with the experiments alluded to by Lord Rosse during the Great Exhibition. The result was this: they sent messages across the Serpentine in the usual way; the wire was then broken. With a gap of six feet the messages still went, and when the distance was increased to sixteen and twenty feet they still went.

Experiments of Mr. Beardmore.—Mr. S. Beardmore, a civil-engineer of London, has recently published a pamphlet on the subject of the applicability of terra-voltaism to submarine telegraphs, in which he gives an account of some hopeful experiments made by him between Cromer and Heligoland, through a line three hundred miles in length. He employed a simple terra-voltaic apparatus, such as he seems convinced must ultimately be used for

long submarine telegraphs, instead of the battery system heretofore in use. The new apparatus consists merely of a couple of earth plates, positive and negative, one at either extremity of the line, no other battery being used. By such means it is anticipated that all necessity for insulation of the wires, or at least dependence on perfect insulation, will be obviated, the electricity evolved by a single voltaic couple, while connected with the respective ends of the wire, having no tendency to escape to the earth during transit. The chief difficulty relates to the question of intensity, as by the single arrangement increase of surface only affords increase of quality, and not of intensity, as by the battery method. Mr. Beardmore thinks that the present sub-Atlantic cable would prove to be not wholly useless, if efforts were made to work it on his terra-voltaic principle.

ON THE GREAT AURORAS OF AUGUST AND SEPTEMBER, 1859.

Professor Loomis, in a paper on the great auroras of August and September, 1859, read before the American Association for 1860, characterized the display as unsurpassed by any on record for magnificence and geographical extent. The disturbance of the magnetic instruments was well-nigh unprecedented for violence, and it may be safely asserted that the phenomena extended over the entire circuit of the globe. The aurora of September 2d formed a belt of light encircling the northern hemisphere, extending southward in America to latitude 22½°, and reaching to an unknown distance on the north; until it pervaded an interval between the elevation of fifty and five hundred miles above the earth's surface. The illumination consisted chiefly of luminous beams or columns everywhere parallel to the direction of a magnetic needle freely suspended. These beams were about five hundred miles in length, and their diameter varied from five to ten or twenty miles, and were, perhaps, sometimes still greater.

IMPROVED GALVANO-PLASTC PROCESS.

An improvement in the method of producing copies of busts, statues, groups, and round ornaments, by the galvano-plastic process, has just been made public. The principle of the invention is the use of conductors so arranged as to spread the electrical current over a large surface. The modes of applying it differ according to circumstances. One plan is as follows: A piece of copper, or of charcoal, is made to represent in miniature the form in outline of the object to be reproduced; this miniature conductor is attached to the negative pole, and then introduced into the interior of the mould, which, of course, is in connection with the same pole; the whole is then plunged together in the bath. The metal is conducted by the various points of this miniature conductor towards all the various hollows which correspond with its prominences. This, however, was but a rude form of the methods adopted. The inventor, M. Lenoir, afterwards substituted for the miniature above described a light frame or mass formed of metallic wire, or of any other conducting material, which he introduced in the same manner into the hollow of the mould; by this means he obtained a large number of conductors, which approached every portion of the interior of the mould, and formed what he calls a mass of nerves for conducting the electricity into the most intricate portions of the hollow mould. These wires also render the decomposition of the solution unusually active,—so much so that the

gas liberated rises constantly to the surface in large beads. The deposit, however, is made with perfect regularity and uniformity.

PROTECTION OF SILVERED SURFACES.

Baron von Liebig has patented certain improvements in protecting the silvered surfaces of mirrors and other articles of glass. This method consists in preparing the silvered surface, by depositing thereon a coating of copper, gold, or other metal, by electro-galvanic action, combined with the use of a neutral solution of the double salt tartrate of the oxide of copper, and soda, potash, or ammonia.

DURABILITY OF ELECTROTYPE WORK.

Mr. E. Richardson, in a communication to the *Builder*, London, gives the following information as to the probable durability of electrotype metal, and its thickness. Mr. Richardson states that in 1844, being called upon to furnish metal medallions, etc., for the granite testimonial to General Sir Alexander Dickson, on Woolwich-common, a very exposed situation, he suggested electrotype castings. A consultation of officers on the question followed, the results being full permission to reproduce the models in electrotype copper, which was ably executed. These castings were at that time of unusual size and thickness, namely, two feet six inches diameter, and fully an eighth of an inch thick of solid metal. This was effected also without shrinking, and every tool-touch from the clay model was reproduced. These works have been now exposed for fifteen years. They weighed, Mr. Richardson believes, thirty pounds each. No chasing was required.

On the other hand, Mr. Richardson has had for years a small brass, about fifteen inches high, produced by the old fire-process, which cost pounds to chase, obliterating every line of his original model, and weighing nearly a quarter of a hundredweight.

NEW APPLICATION OF ELECTRO-METALLURGY.

Among the recent applications of electro-metallurgy we may instance the happy idea of Mr. Gaudin of employing it in setting jewels. This is a very delicate and expensive branch of jewelry, and so difficult that the setting of a jewel can seldom be fully relied upon. The inventor first takes a mould in wax of the ornament that is to receive the jewels, then places on it, at the proper points, the jewels, embedded in the wax to a sufficient depth; the wax model, rendered a conductor of electricity, is placed in the gold solution, and the metal deposited upon it. When the deposit is completed, the jewel is found firmly enchased in the metal, from which, if the process has been properly conducted, it will be impossible for the jewel to escape. The saving of time effected by this process is also very considerable. By the ordinary process a jeweller can scarcely set sixty jewels in a day, but by the new process he can set as many as fifteen hundred to two thousand in a day.

LAST OF THE ATLANTIC CABLE.

During the past summer, several attempts have been made to elevate and recover the American end of the Transatlantic telegraph; but in every in-

stance in which it was hooked up to the surface it soon broke, and was finally abandoned. The following extracts from the log of the party employed will, however, be read with interest, as the last transaction connected with this gigantic but unfortunate enterprise: —

On the 12th of June, Captain Kell succeeded in fishing up and buoying the end, after recovering three-quarters of a mile of the cable.

On the 14th operations were resumed, and three miles and a half of cable recovered, when a fracture occurred.

On the 23d the cable was hooked in ninety fathoms, and parted both ways, the bight and a short piece of cable coming on board.

25th. The cable was hooked again, but parted when within fifteen fathoms of the surface, as it had done on several previous occasions.

27th. Grapnelling was resumed in one hundred and fourteen fathoms; the cable was hooked several times, and with one exception parted before reaching the surface. Care was taken to buoy the spot the moment the cable broke, and by grapnelling from a quarter to half a mile east of the buoy we hoped to succeed in raising the bight, and did at last get it on board. On testing the cable towards Ireland, it was found to be broken a very short distance from the vessel, three-quarters of a mile of cable being recovered before it parted again at a weak place.

28th. The wind and sea too high for working. A fresh consultation was held as to the best mode of proceeding, and it was resolved to go further out at once, hoping thereby to avoid the rocky ground and the bad state of the cable.

30th. The cable was hooked three times from the steamer, in one hundred and thirty fathoms of water, but broke before reaching the surface. At last a bight came on board, the cable at this spot being unusually good for about thirty yards; the outer end was found to be broken about two hundred yards off. About two miles of the inner end were recovered, when it parted again at a weak place, where there was nothing but the gutta percha covered wire left; this, however, was just able to bring the cable to the surface, when it snapped before it could be secured by a stopper. Although mud is shown on the charts, there are most unquestionably rocks also, as was too plainly indicated by the state of the cable, rock weed and sea animalcules adhering to and surrounding it in many places, showing that it had been suspended clear of the bottom. The cable was invariably hauled in by hand to avoid unnecessary strain. The recovered cable varied in condition very much, and what is most important is, that even those portions which came out of the black mud were so perished in numerous patches that the outer covering parted on board, during the process of hauling in, and but for the dexterity and courage of the men in seizing hold of it beyond the break, where the iron wires stuck out like bunches of highly-sharpened needle points, we should not have known so much of its condition. In a word, it was evidently sometimes embedded in mud, sometimes on small stones, sometimes half embedded, and sometimes wholly exposed over rocks, as was apparent from the condition of the outer covering. The iron wires in many places often appeared sound, but, on minute inspection, were found eaten away and rotten; the sewing was also decayed. In some places the iron wires were coated with metallic copper, and much eaten, they having most probably rested upon copper ore, for there are veins of it in Trinity Bay. The gutta percha and copper wire are, however, in as good condition as when laid down.

The general ragged, precipitous, and rocky character of the surrounding

land evidently extends below the surface of the water; the unevenness of our soundings and condition of the cable indicate this most plainly. We accordingly decided upon leaving the neighborhood of Bull's Island altogether, as the cable in its present state at that part of the bay will not repay the cost of recovery. We agreed simultaneously to attempt to raise the cable off Heart's Content, and ascertain its condition there; this being the most promising part of the bay, from the information we have been able to collect. Accordingly, on the 1st of July, we sailed to this locality, and grappelled for the cable in smooth water. We finally hooked it, in one hundred and forty-three fathoms water, some four times or more. It sometimes lifted off the ground before parting as much as forty fathoms, sometimes only fifteen; in no instance did it come near the surface of the water. On two occasions the iron strands of the cable left most unmistakable impressions on the grapnel, and iron rust, resembling that usually found on the cable, adhered to its claws. The bottom consisted of green mud and light-colored clay, the latter very compact, and in consistency not much unlike the blue clay of London; some parts of the bottom were of stone.

Having found it quite impossible to raise the cable, we concluded, after careful consideration, to make a last, but hopeless, trial at the mouth of Trinity Bay, and if unsuccessful to take the steamer and men to St. John's, to avoid further expense. On July 3d, the steamer reached Break Heart Point, a little before 4 A. M. We grapnelled for the cable from about six and a half miles off, in one hundred and sixty-five fathoms water, to within one and a half miles of the point, where the water was still over one hundred fathoms. We did not succeed in finding it; and had we done so, the Atlantic roll setting into the bay was so heavy, and the current running out so strong, that we could not possibly have raised it to the surface, but only have determined its position. It is quite possible that the cable was hooked without being perceived by us, owing to the depth of water, and to the fact that the cable, especially where laid over stone, is very rotten. At six miles out, the bottom consisted of clay covered by a thin stratum of mud. At about four and a half or five miles off, the bottom appeared to consist of stones, and this continued to within one and a half miles of the "point," where the water was very deep. Those portions of the recovered cable that were wrapped with tarred yarn were sound, the tar and hemp having preserved the iron wires bright and free from rust. This will be further reported on when the pieces of recovered cable have been more closely examined.

ON THE PRESENT CONDITION OF SUBMARINE TELEGRAPHING.

The unfortunate failure of the Atlantic Telegraph, with its long series of mistakes and miscalculations, has exercised, and still to a certain extent continues to exercise, a depressing influence upon all important schemes for submarine telegraphic communication. We can scarcely say that confidence in the working practicability of any Atlantic telegraph whatever, submerged along the old deep-sea route, has yet been established, while, regarding such a scheme merely in the light of an investment, a commercial speculation by which money is to be made, we need not remark how, at the present time, even the best inaugurated enterprise of the kind would soon have the grief of seeing its shares at half discount, unless the most rigid and practised caution was exercised both in the choice of route and choice of cable. In

the meantime, during the stagnation that has engulfed all such projected schemes since the Atlantic cable was designed and lost, a great reform in the method of constructing submarine ropes has been going steadily forward. The old self-destructive principle of ponderous iron coils for deep-sea wires has been so generally abandoned, that a proposition for now reverting to their use across a sea of any length or depth would not be entertained for a moment by telegraphic engineers. To be sure, this change, which of course was, and still is, fiercely opposed by some of the wire ropemakers, has not been brought about till the credulity and patience of shareholders were at an end, and until the bottom of the Mediterranean and other seas had been fruitlessly adorned with three or four of those leviathan coils,—enduring monuments of our commercial enterprise, and of our mechanical ignorance also. Since that period—only four years ago, though marking an age in the infant science of telegraphy—opinions have undergone a most important change, and both contractors and engineers now often lean so strongly to very light cables, that the idea, like all good ideas, is in danger of being led into extremes, and we may see as much public money lost in trying to submerge cobwebs as was ever dragged down "fathoms deep," even by those expensive wire covered cables, big enough and heavy enough to moor an island. The results of this great alteration in the weight and strength of cables are likely soon to be practically tested on the most extensive scale, by the proportionate success or non-success of some cables which are now being manufactured in England. One is about the very lightest cable of its kind that has ever been made at all, always excepting the gutta-percha covered copper wire which was stretched across the Black Sea to Balaklava. The other is to be a well proportioned "composite" cable, heavy and very massive, perhaps far too much so in some parts; in others, where it is proposed to be sunk some three miles down, it is, if not quite a light rope, still, with regard to lightness, an important example in the right direction.

The first mentioned extremely light cable, which will weigh less than three hundredweight per mile in water, is about being constructed at the Electric Cable Company's works, Milwall. The heavier, and we must also say the more expensively proportioned, rope is in progress of manufacture at Glass & Elliot's for the English government, and will, it is hoped, unite England with Gibraltar. In this cable all questions of cost have been considered at the treasury as entirely subordinate to procuring the very best workmanship and material,—the highest conditions of mechanical and electrical excellence which it is possible to secure by money, toil, or ingenuity. The direct route from England to Gibraltar would, for the most part, lie through what in telegraphic works would be called deep water,—the route from Brest to Finisterre, and so on round the coast of Portugal, at a comparatively short distance from land, averaging on the whole either one thousand or more than one thousand fathoms. But in this cable (as should have been the case with every one that has ever been made) the contract with Glass & Elliot is not only for its manufacture on a certain plan, but for submerging it successfully. The depth of water in which it will ultimately be laid will therefore, doubtless, rest in a great measure with the contractors; subject, of course, to certain conditions of the government, that it shall be sunk in water deep enough to keep it out of the reach of any enemy, either to raise or to break. The latter consideration is, of course, one of the last importance; since only in war time will attempts be made to injure it, and

in war time, above all others, its services would be absolutely indispensable to the country.

Before the form, weight, strength, and outer covering of each portion of the cable were resolved on, the Board of Trade took the utmost pains, by consulting our chief electricians, to ascertain the kinds best suited for the purpose and for long endurance under water. Researches into these matters have led to the adoption of a cable of different thicknesses, weights, and strengths, according as the depth of the water under which it will be laid increases; the whole forming one continued submarine rope, which, if not perfect in its mechanical arrangement, is nevertheless one which holds out high prospects of ultimate success. The core or conductor is, of course, of the same thickness and formation throughout from end to end, being formed of seven No. 18 copper wires, in all about one-eighth of an inch diameter — the thickest conductor that has ever yet been made. The copper strands of this, in accordance with the advice of the electricians, have been very carefully selected and tested for conducting power, as even the purest copper wire, from some unknown cause, has been found to vary in electrical conducting power as much as forty per cent. Its power of conducting heat also diminishes or increases in the same proportion with its electrical sensitiveness. Yet, though the conductor with its insulating medium of gutta-percha is alike in diameter throughout, the manner in which this core is protected, or, we had better say, the thickness to which the outer covering is laid on, differs considerably. Thus, each of the two shore ends is made to rest in from 100 to 200 fathoms, and these for thirty knots each way are very massive, at the rate in weight of seven tons to the mile. The next length at each end is also of thirty knots, and will rest in from 200 to 400 fathoms water, and is for this depth a very massive cable, weighing about five tons to the mile. By the substitution of a finer gauge of wire at each two or three miles or so, this gradually tapers down to meet the first deep-sea length, which will be laid in from 500 to 800, or, possibly, even 1,000 fathoms. The length of this portion of the cable is 940 nautical miles, its weight in air two tons per mile, in water about thirty-four hundredweight. The deepest deep-sea portion — across the centre of the Bay of Biscay — extends over about 280 knots, though 360 knots are being manufactured to meet contingencies in submerging. Here the depth averages about 2,500 fathoms, — equal to the very deepest parts of the cable plateau of the North Atlantic. To overcome the difficulties of this vast depth of water, the cable is strengthened by the introduction of steel wire in its outer covering, and reduced to weigh in air only twenty-six hundredweight; in water as low as thirteen. The weight of the Atlantic cable in air was one ton, and in water about fifteen or sixteen hundredweight, per mile.

The different weights of the different parts of the cable are, of course, entirely due to the thickness of the outer spiral wires with which it is covered. The conductor, with its threefold insulation of gutta-percha, is all served round alike with yarns of tarred hemp closely bound in, and over which come the outer wires of various gauges: No. 1 gauge, the thickest known, being as thick as a cedar pencil, and so on up to No. 45 gauge, as fine as cotton. The two heaviest shore ends, then, of thirty miles each, are covered with twelve No. 3 gauge wires, which brings its weight up to seven tons a mile, and its breaking strain from twenty-five to thirty tons. The second land ends are enclosed in twelve No. 5 gauge wires, of five tons to the mile, and equal to about fifteen tons' strain.

The first deep-sea length, of about nine hundred and fifty miles, for from five to eight hundred fathoms, is covered, like the Atlantic cable, with eighteen No. 11 gauge solid iron wires, weighing two tons the mile in air, thirty-three hundredweight in water, and equal to a strain of nearly eight tons. The deepest sea part is enclosed in twelve steel wires of No. 14 gauge, each wire being spun round and enclosed in a separate strand of hemp, in order, if possible, to take off that dangerous springiness and tendency to kink which makes all steel-wire rope, even when coiled, so lively, and so much resembling a cargo of live eels. The cable, the chief points of which we have thus described, is necessarily a most expensive one; for, as we have already stated, the government have contracted that all parts of the material and workmanship should be of the finest possible kind.

Nevertheless, in spite of all the care that has been taken to secure a good rope, and the improvement which, with regard to strength with a certain amount of lightness, the deep-sea portion of this cable undoubtedly displays, it is still, we are sorry to say, constructed on the old self-destructive principle of spiral iron wires round a soft core,—one of the most faulty mechanical arrangements that could have been attempted. There is not a single engineer of eminence who does not condemn the principle of laying on the outside wires spirally, instead of longitudinally, in a line with the strain they have to resist. Why the old arrangement is persisted in at the present day it is difficult to imagine, unless it is due to the fact that most of the wire-rope manufacturers have their machines constructed for laying on the wires spirally, and do not care to make others which will render the completion of their work slower, more difficult, and less profitable. Four years ago, when the plan of construction of the Atlantic cable was resolved on, we most strongly deprecated this arrangement, and the event has so clearly justified what we then pointed out would be the consequences, that we may be excused for quoting the opinion on the present occasion:—

"Whenever a cable is constructed with spiral wires round a soft core, any severe strain in paying it out must, by stretching the outside wires, either attenuate or break the insulation of the copper conductor. This is a simple fact, which those least conversant with mechanics can easily understand. We do not mean to say that the Atlantic cable cannot succeed, but the chances are very much against it; and it is certain that before it has been down twelve months it will, like most others similarly constructed, be perfectly useless. If it does answer even temporarily, it will not be due to the plan on which it is made, but in spite of it."

We shall, on another occasion, inform our readers of the chief principles on which the light cable before mentioned is being constructed, and the prospects which cables of that description hold out of being successful when laid. All that we have at present to add with regard to the Gibraltar cable is, that the contractors undertake to submerge it at their own risk and expense; and to insure proper fulfilment of this portion of their task, the government very wisely retain five per cent of the price of the whole cable (which is nearly £300,000) in their own hands, and further compel Messrs. Glass and Elliot to give security to the amount of £20,000 that the rope shall be successfully laid. It is proposed to submerge it in two equal portions — one from Gibraltar to Cape Finisterre, and one from Finisterre to (we hope) the southwest coast of Ireland. It is anticipated that the whole rope will be laid early in 1861. — *London Times.*

IMPROVEMENTS IN TELEGRAPHIC APPARATUS.

Several improvements in the operation of the Morse telegraph have recently been completed in England. One by the brothers Digney marks the characters with ink, instead of simple indentation in the paper. This is a relief to the eyes of the operator, and an additional guaranty of accuracy. This is accomplished by making immovable the instrument for tracing, which is a simple desk turning upon itself; the lever, moved by electricity, has no other function than to press the paper against the desk at divers intervals and for different lengths of time. By a clockwork movement this little desk rubs constantly against an elastic roller saturated with a fat ink, which long preserves its fluidity, so that it suffices to put a few drops of it every two or three days on the surface of the roller. This improvement has been adopted on the lines in France and Belgium. Mr. Wheatstone, of England, has also invented a convenient process for increasing the speed of transmission by the Morse instrument, similar to a process for the same purpose connected with the Bain instrument. A prepared paper is punched with holes corresponding to the Morse characters, and the message thus prepared is placed on a moving metallic band, and is made to take the place of an operator and transmit itself.

L. Bradley, of New York, has patented an improvement in telegraphing by sound, by which he dispenses with the local batteries of the House system. The magnet and armature are placed in the main circuit, and by a simple combination of sounding-board and overstrung wires the indistinct tick is expanded to a clear, sharp, and perfectly intelligible knock, which the operator can follow with perfect ease and certainty. Each knock is loud and abrupt, and there is not the slightest liability of running them together, however rapid the manipulations of the operator.

MAGNETISM AND THE MOON.

At the American Association, 1860, Professor Bache presented a paper on the attempt, from observations at Girard College, to determine the effect of the moon upon the daily movements of the magnetic needle. The observations and calculations of European magnetic observers have shown that such an effect is produced. The Philadelphia observations were divided into three groups, and the curves of each group were found to agree with each other, and with the results of General Sabine and others. Fourteen minutes after the moon is on the meridian, the needle is eighteen-hundredths of a minute westerly of its position, and six minutes after the moon passes the lower meridian, twenty-three hundredths of a minute west; while about moon-rise and moon-set the needle is nearly as much east of its position. There is also a slight single movement between two successive culminations of the moon, just as there is a daily, as well as a semi-daily, lunar tide in the ocean. Further examinations show a greater effect of the moon in summer than in winter. Moreover, it appears that the effect is probably greater at new moon than at full, and greater when the moon is north of the equator than when south. The effect when the moon is near the earth is greater than when she is at a greater distance. But it must be remembered that all these effects are exceedingly small.

ON FIXING MAGNETIC PHANTOMS.

The name "phantom" was given by M. de Haldat to the figures which are obtained when iron-filings are thrown upon a sheet of paper or a pane of glass placed over a magnet. This physicist fixed these images by producing them upon a sheet of paper coated with starch or prepared with gelatine.

This process certainly enables us to obtain the general form of the phantoms; but all physicists can see that it suppresses the details. I therefore propose another method, which is very simple, and succeeds perfectly. The paper upon which the phantoms are to be fixed is "waxed" paper. A sheet of this is placed over the poles of the magnet in question, and kept in a horizontal position by means of a screen placed between the paper and the magnet. Then, proceeding in the usual manner, when the image is fully developed, a hot brick is held above it, or the warm lid of a crucible, which is preferable, because it is lighter and easily managed with the tongs. They must not touch the paper, but only be brought within the distance necessary to fuse the wax. As soon as this happens, which is easily perceived by the glistening appearance produced, the brick is withdrawn. Meanwhile the current does not cease its activity, nor the filings lose their arrangement, in which position the whole solidifies so well that the fixed image does not at all differ from the phantom of the magnet in activity. Permanence is thus given to the sort of molecular arrangement which the filings take when exposed to magnetic influence. Instruction can hardly fail to be derived from the use of these means, by aid of which it will be possible to study the figures more advantageously, which are, in some sense, the visible expression of the force animating bodies endowed with polarity developed by magnetism. — Professor J. Nickles, *Silliman's Journal.*

ELECTRIC AND CALORIFIC CONDUCTION OF METALS.

Messrs. Calvert and Johnson, after numerous experiments, have arrived at the conclusion that the electric and calorific conduction — powers of conducting heat and electricity — are proportional to each other in alloys as well as in simple metals; and that these powers are exhibited by the alloys of copper and zinc in a degree which differs little from that of zinc, whatever amount of copper they may contain. The rapidity with which the conduction of copper is reduced is very remarkable. Thus pure copper conducts electricity with a facility represented by the figures 73.6, and heat with one represented by 79.3; but when eight parts of copper are alloyed with one part of zinc, the conductibility for electricity is reduced to 27.3, and for heat to 25.5; that of zinc alone being for the former 28.1, and for the latter 27.3. The conductibility of alloys of tin and bismuth is nearly the mean of that of the component metals.

ON THE CONSERVATION OF FORCE.

Professor Faraday, in a recently published volume, entitled "Experimental Researches in Chemistry and Physics," adds to his former expressed opinions, in relation to the conservation of force,[1] the following additional remarks: —

[1] See Annual of Scientific Discovery for 1858, pp. 177-189.

Since the first publication of certain opinions respecting gravitation, etc., I have come to the knowledge of various observations upon them, some adverse, others favorable: these have given me no reason to change my own mode of viewing the subject; but some of them make me think that I have not stated the matter with sufficient precision. The word "force" is understood by many to mean simply "the tendency of a body to pass from one place to another," which is equivalent, I suppose, to the phrase "mechanical force." Those who so restrain its meaning must have found my argument very obscure. What I mean by the word "force," is the *cause* of a physical action; the source or sources of all possible changes amongst the particles or materials of the universe.

It seems to me that the idea of the conservation of force is absolutely independent of any notion we may form of the nature of force or its varieties, and is as sure, and may be as firmly held in the mind, as if we, instead of being very ignorant, understood perfectly every point about the cause of force and the varied effects it can produce. There may be perfectly distinct and separate causes of what are called chemical actions, or electrical actions, or gravitating actions, constituting so many forces; but if the "conservation of force" is a good and true principle, each of these forces must be subject to it: none can vary in its absolute amount; each must be definite at all times, whether for a particle, or for all the particles in the universe; and the sum also of the three forces must be equally unchangeable. Or, there may be but one cause for these three sets of actions, and in place of three forces we may really have but one, convertible in its manifestations; then the proportions between one set of actions and another, as the chemical and the electrical, may become very variable, so as to be utterly inconsistent with the idea of the conservation of two separate forces, — the electrical and the chemical, — but perfectly consistent with the conservation of a force being the common cause of two or more sets of action.

It is perfectly true that we cannot always trace a force by its actions, though we admit its conservation. Oxygen and hydrogen may remain mixed for years without showing any signs of chemical activity; they may be made at any given instant to exhibit active results, and then assume a new state, in which again they appear as passive bodies. Now, though we cannot clearly explain what the chemical force is doing, that is to say, what are its effects during the three periods before, at, and after the active combination, and only by very vague assumption can approach to a feeble conception of its rèspective states, yet we do not suppose the creation of a new portion of force for the active moment of time, or the less believe that the forces belonging to the oxygen and hydrogen exist unchanged in their amount at all these periods, though varying in their results. A part may at the active moment be thrown off as mechanical force, a part as radiant force, a part disposed of we know not how; but believing, by the principle of conservation, that it is not increased or destroyed, our thoughts are directed to search out what, at all and every period, it is doing, and how it is to be recognized and measured. A problem, founded on the physical truth of nature, is stated, and, being stated, is on the way to its solution.

Those who admit the possibility of the common origin of all physical force, and also acknowledge the principle of conservation, apply that principle to the sum total of the force. Though the amount of mechanical force (using habitual language for convenience' sake) may remain unchanged and definite in its character for a long time, yet when, as in the collision of

two equal inelastic bodies, it appears to be lost, they find it in the form of heat; and whether they admit that heat to be a continual mechanical action, —as is most probable,—or assume some other idea, as that of electricity, or action of a heat-fluid, still they hold to the principle of conservation, by admitting that the sum of force, that is, of the "cause of action," is the same whatever character the effects assume. With them the convertibility of heat, electricity, magnetism, chemical action, and motion, is a familiar thought; neither can I perceive any reason why they should be led to exclude, *à priori*, the cause of gravitation from association with the cause of these other phenomena respectively. All that they are limited by in their various investigations, whatever directions they may take, is the necessity of making no assumption directly contradictory of the conservation of force applied to the sum of all the forces concerned, and to endeavor to discover the different directions in which the various parts of the total force have been exerted.

Those who admit separate forces inter-unchangeable, have to show that each of these forces is separately subject to the principle of conservation. If gravitation be such a separate force, and yet its power in the action of two particles be supposed to be diminished fourfold, by doubling the distance, surely some new action, having true gravitation character, and that alone, ought to appear; for how else can the totality of the force remain unchanged? To define the force "as a simple attractive force exerted between any two or all the particles of matter, with a strength varying inversely as the square of the distance," is not to answer the question; nor does it indicate, or even assume, what are the other complementary results which occur, or allow the supposition that such are necessary: it is simply, as it appears to me, to *deny* the conservation of force.

As to the gravitating force, I do not presume to say that I have the least idea of what occurs in two particles when their power of mutually approaching each other is changed by their being placed at different distances; but I have a strong conviction, through the influence on my mind of the doctrine of conservation, that there is a change; and that the phenomena resulting from the change will probably appear some day as the result of careful research. If it be said that "'twere to consider too curiously to consider so," then I must dissent: to refrain to consider would be to ignore the principle of the conservation of force, and to stop the inquiry which it suggests; whereas, to admit the proper logical force of the principle in our hypotheses and considerations, and to permit its guidance in a cautious yet courageous course of investigation, may give us power to enlarge the generalities we already possess in respect of heat, motion, electricity, magnetism, etc., to associate gravity with them, and, perhaps, enable us to know whether the essential force of gravitation (and other attractions) is internal or external, as respects the attracted bodies.

Returning once more to the definition of the gravitating power as "a simple attractive force exerted between any two or all the particles or masses of matter at every sensible distance, but with a *strength varying* inversely as the square of the distance," I ought, perhaps, to suppose there are many who accept this as a true and sufficient description of the force, and who, therefore, in relation to it, deny the principle of conservation. If both are accepted, and are thought to be consistent with each other, it cannot be difficult to add words which shall make "varying strength" and "conservation" agree together. It cannot be said that the definition merely applies to the *effects* of gravitation as far as we know them. So understood, it would form

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no barrier to progress; for that particles at different distances are urged towards each other with a power varying inversely as the square of the distance is a truth; but the definition has not that meaning; and what I object to is the pretence of knowledge which the definition sets up when it assumes to describe, not the partial effects of the force, but the nature of the force as a whole.

THE CORRELATION AND HOMOGENESIS OF PHYSICAL FORCES.

The following article, written by L'Abbé Moigno, was recently published in the London *Photographic News:* —

All the forces of nature — motion, heat, light, electricity, magnetism, chemical affinity — have intimate relations or correlations with each other. These forces engender each other; so that, one being given, we can, by putting it into action, produce all the others. This generation or homogenesis of the various forces by each other takes place in definite proportions, or according to the law of fixed equivalents; so that the quantity of any one of these forces expended in the act of generating another force is always represented by a corresponding quantity of the force engendered. Thus, for example, if, to create a mechanical force, we expend, without loss, the quantity of heat necessary to raise a kilogramme of water one degree of heat, the mechanical force produced will be capable of raising, in a second of time, 427 kilogrammes to the height of a meter; and reciprocally, if, to produce one degree of heat, we expend the force capable of raising a meter in height, in one second, a weight of 427 kilogrammes, the quantity of heat engendered will be that necessary to communicate, and will suffice to communicate to a liter of water one degree of temperature. M. de Beaumont's machine admirably demonstrates this fundamental principle, which will receive its full development when science shall have become able to define and accurately determine the mechanical, thermal, photogenic, electric, magnetic, and synergic equivalents as clearly and accurately as it has arrived at determining the chemical equivalents of various simple and compound substances.

But this is not all. In making another step in advance, we have established, as a certain proposition, that the generation or homogenesis of the various forces of nature is accomplished by a real transformation of one into another; so that, for example, heat, under given conditions, is transformed into a motive power, into light, electricity, magnetism, and chemical affinity; or, rather, becomes motive power, light, electricity, magnetism, and chemical affinity. The beautiful experiment of Faraday, completed and fully developed by Foucault, of a cube submitted to rapid motion becoming hot when this motion suddenly stopped, is the sufficient and certain demonstration of the transformation of the quantity of motion into the quantity of heat — a transformation regulated by the principle of equivalents. At length we arrive at the theory or metaphysical reason of these intimate relations of the homogenesis, of these mutual generations or transmissions, always obeying the laws of equivalents. Our profound conviction is, that Mr. Grove and M. Seguin are perfectly correct when they assert that in nature there are only two things, matter and motion; matter under two forms, and submitted to the law of universal attraction; motion once impressed on matter, which cannot augment either in its quantity or in the sum of its active forces, which may be successively transformed and modified.

When a ray of light falls upon a daguerreotype plate, forming part of a galvanic circuit, which includes a galvanometer and Breguet's metallic thermometer, there is instantaneously and simultaneously produced chemical affinity on the surface of the plate, an electric current in the galvanometer, an elevation of temperature in the thermometer, motion in the two needles of the galvanometer and thermometer, etc. As a concrete and striking example of homogenesis, we may instance what we will term the human machine, that masterpiece of creative power. It is sustained solely, first by alimentary provision, composed of carbon, hydrogen, nitrogen, and assimilative mineral principles, then by atmospheric air introduced by respiration. The vital phenomenon, *par excellence*, is the combustion of carbon and hydrogen by the oxygen of the atmosphere — a combustion which, it appears to us, is summed up in a first disengagement, in a first motion, in a first circulation. Now, observe to what this first motion gives birth: a very intense heat, which maintains our whole body, even in winter, at a temperature of ninety-eight degrees Fahrenheit; an electric or nervous current, of which M. Helmholtz has established the existence and measured the velocity; the circulation of the blood in the entire system of arteries and veins; a mechanical force sufficient to transport the entire body which, upon an average, weighs 160 pounds, with a velocity of several yards per second; the muscular force exercised by the various organs, which make of an active man one of the strongest animals in creation; chemical affinity, under a thousand different forms, with the very complex series of combinations and decompositions, assimilations and secretions, etc.: evidently, this is not only the correlation of physical forces, it is also their homogenesis, their mutual transformation, their identity in cause and also in nature, etc.

NEW COSMICAL FORCE.

Jacobi, of St. Petersburg, well known to the scientific world for his fine researches on light and magnetism, has recently thrown out some remarkable ideas on the necessity of introducing into calculations of the planetary system a new force, besides gravitation, namely, *induction*. The numerous practical applications of the remarkable force, electro-magnetism, he says, have rather pushed out of sight the vast importance of the discovery in a purely scientific point of view, and observes that he has no scruple in placing it by the side of gravitation as a force in celestial mechanics. Here are a few of the most intelligible links in his chain of reasoning: All bodies are magnetic to a greater or less degree; the earth is a vast magnet, and it is doubtless the same with other planets and their satellites, and even with the sun himself. Now it is a general law, and also a fact proved by everyday experience, that when two bodies, both permeated by magnetic currents, approach or recede from each other, their approach or their recession generates contrary currents of induction. And it is these currents of induction, with their consecutive and perturbative attractions or repulsions, that he proposes to introduce into the explanation of the phenomena of celestial mechanics.

INFLUENCE OF LIGHT IN GRAVITATION.

The following is an abstract of an essay on the above subject, by Dr. Wm. S. Green, of Muscogee County, Georgia: —

1. It is argued that gravitation is an action of contiguous atoms of matter,

impressible by light. 2. That the velocity of motion of these atoms toward each other is a measure of the force of gravity. 3. That the velocity of these moving atoms is equal to the velocity of light.

It is further argued that the force of gravity makes angles and surfaces on the earth, coinciding with those of light from the sun; and that, like light, it is modified by the density and masses of matter through which it passes. The mean direction of the solar force on the earth must be toward that point which would indicate the place of its mean weight. This must be at the centre of gyration, since that is the point at which, if all the matter were collected, it would revolve with the same velocity. According to Mr. Farey, the distance of the centre of gyration from the centre of motion, in a solid sphere revolving about one of its diameters as an axis, is found by multiplying its radius into .6325 decimal. The earth's radius being 3956 miles, when multiplied by .6325 gives 2502 miles, as the distance of the centre of gyration in the earth from the centre of motion.

All the matter of the earth's surface lying within the parallels 54° 26′ north and south of the equator, has its gravity diminished by the action of the sun, and increased beyond them to the poles. Gummere, in his work on Astronomy, chap. XVII. 70, estimates the angle of diminished gravity at the earth's surface produced by solar action at 55°.

If the whole surface of the earth is represented by unity, then that surface embraced between the parallels of 23° 27′ 54″ will be represented by .398125 decimal. These surfaces are in the ratio of spheres of matter, the relative masses of which are as 1 to .25 decimal, and the diameters of which are as 1 to .631 decimal. The above masses are in the ratio of the relative densities of the sun and earth; and the diameters are in the ratio of radius to the distance from the centre of gyration to the earth's centre. These numbers also represent the relative velocity of the extremes of decomposed solar light, the number of red undulations in an inch being .37640, while that of the violet undulations is .59750 in an inch. Considering the earth as a spheroid, they also represent the velocity of the earth's rotation at the equator, and at the parallels of 54° 26′; or *the extremes of the solar force on the earth's surface.*

The planets are supposed to be collections of atoms of matter in motion. The force of their gravity toward each other, and consequently to the sun, ought to be known by the velocity of their atomic motion toward each other. Hence, *their distances from the sun ought to be inversely proportional to their densities.* The following shorter process of Kepler's Third Law gives the inverse ratio of velocities, which squared gives the distance of the planets:

Mercury,	$\sqrt[3]{87.969}$	days =	4.772	ratio	0.625	These numbers squared give ratio of distances.	.3906
Venus,	$\sqrt[3]{222.700}$	" =	6.080	"	0.850		.7225
Earth,	$\sqrt[3]{365.256}$	" =	7.148	"	1.000		1.0000
Mars,	$\sqrt[3]{686.979}$	" =	8.823	"	1.234		1.5227
Jupiter,	$\sqrt[3]{4332.584}$	" =	16.299	"	2.281		5.2029
Saturn,	$\sqrt[3]{10759.219}$	" =	22.176	"	3.088		9.5337
Uranus,	$\sqrt[3]{30686.820}$	" =	31.309	"	4.380		19.1844
Neptune,	$\sqrt[3]{60127.000}$	" =	39.198	"	5.483		30.0632

If the earth's true distance, found from the above figures, be divided by

the distances of the other planets, we have the ratio of densities; which coincide very nearly with the densities given by Laplace, in the third column.

	Distances. Miles.	Earth's distance divided by the others gives	Density.	Density from Laplace.
Mercury,	370,674		2.560	2.585
Venus,	685,598		1.384	1.024
Earth,	948,925		1.000	1.000
Mars,	1,444,982		.687	.655
Jupiter,	4,937,223		.192	.201
Saturn,	9,048,712		.104	.103
Uranus,	18,204,570		.052	.218
Neptune,	28,527,828		.037	....

In Biot's Astronomy the density of Mercury, resulting from the diameter and mass there given, is 3.097; but in the author from whom Olmsted copies, it is put down as 1.12. Laplace is between them.

It has been shown that the square roots of the distances of the planets are inversely proportional to their velocity of revolution. Hence, the nearer a planet approaches the sun, its velocity is more and more increased. At the distance of one mile, therefore, from the sun, the velocity of the earth's revolution around it would be nineteen miles per second, multiplied by the square root of 94892572 miles, which equals $19 \times 9744 = 185136$ miles per second, which *is very nearly the estimated velocity of light.* The atoms of terrestrial matter, therefore, if placed at the surface of the sun, would have a motion equal to the velocity of solar light.

If the resistance of atoms of matter retards the velocity of light and modifies the force of gravity, the amount of such retardation ought to be in some ratio with the *number of atoms, or masses of the planets.* It is found that the sixth roots of the masses represent this retardation. The times of rotation of the planets, therefore, should be in the ratio of the square roots of the cube roots, that is, the sixth roots of the masses.

	Mass.		Ratio.		Times of rotation. h. m. s.
Mercury,	$\sqrt[6]{3465}$	=	.715	or	33 29 09
Venus,	$\sqrt[6]{1.32213}$	=	1.048	"	22 55 57
Earth,	$\sqrt[6]{1.00000}$	=	1.000	"	24 00 00
Mars,	$\sqrt[6]{.12535}$	=	.707	"	33 54 28
Jupiter,	$\sqrt[6]{272.77232}$	=	2.546	"	9 23 00
Saturn,	$\sqrt[6]{103.48990}$	=	2.169	"	11 07 00
Uranus,	$\sqrt[6]{4.49940}$	=	1.270	"	18 45 00
Neptune,	$\sqrt[6]{2.21111}$	=	1.147	"	20 56 32

GROWTH OF A CRYSTAL.

Mr. Nevil Story Maskelyne, in a paper read by him to the Royal Institution, " On the Insight hitherto obtained into the nature of the Crystal Molecule by the instrumentality of Light," in conclusion, says: —

In every case the growth of a crystal is an inexplicable thing, so long as we endeavor to trace its cause to powers residing in, and confined to, the

molecules. A crystal, like a plant, is developed in a medium; and as the plant owes the special peculiarities of its individual form, notwithstanding the seemingly perfect freedom of its growth, to special circumstances in the soil, the air, the weather, during that growth; and its general similarity to other plants of its kind, to the organic laws that control the conditions of its species; so must the crystal be considered as the result of many coöperating influences, including those of the foreign constituents of the mother liquid, those of temperature and other physical conditions, and involving the principle that the molecules, whether those deposited, or those about to become so, affect or are affected by — and that to considerable distances — the whole of the formed and forming crystal matter.

It would be as useless to expect to explain the growth of a crystal without some such view as this, as to endeavor to account for the growth or outward form of a particular plant by the development of a single leaf.

CURIOUS NUMERICAL RELATIONS.

Col. James, R. E., in a communication to the London *Athenæum*, points out the following curious relations of numbers: —

The length of a solar year is 365.242 days. The length of a degree of longitude at the equator, taken from the printed Geodetical Tables of the British Ordnance Survey, is 365,234 feet; so that if the length of a degree at the equator is divided by the number of days in the year, it will give 1,000 feet, or, more exactly, 999.977 feet, which would give the foot within one thousandth part of an inch, a quantity which cannot be seen.

Again, the length of a degree of latitude at the central point of the British Islands is 365,242 feet, and the length of a degree of latitude, measured on that parallel, divided by the number of days in the year, gives exactly 1,000 feet.

There is no connection between the number of days in a year and the number of feet in a degree of latitude or longitude; but after a lapse of a few thousand years, the scientific traveller from New Zealand may pay us the same compliment which some of our scientific travellers are now paying the Egyptians, and attribute to scientific refinement that which is simply a curious accidental agreement in the numbers.

DYNAMICS OF GASES.

The following is an abstract of a paper presented to the British Association, "On the Dynamical Theory of Gases," by Professor C. Maxwell. The phenomena of the expansion of gases by heat, and their compression by pressure, have been explained by Joule, Claussens, Herepath, etc., by the theory of their particles being in a state of rapid motion, the velocity depending on the temperature. These particles must not only strike against the sides of the vessel, but against each other, and the calculation of their motions is therefore complicated. The author has established the following results: — 1. The velocities of the particles are not uniform, but vary, so that they deviate from the mean value by a law well known in the "method of least squares." 2. Two different sets of particles will distribute their velocities, so that their *vires vivæ* will be equal; and this leads to the chemical law, that the equivalents of gases are proportional to their specific gravities. 3. From Professor Stokes's experiments on friction in air, it appears that the

distance travelled by a particle between consecutive collisions is about $\frac{1}{447000}$ of an inch, the mean velocity being about 1,505 feet per second; and therefore each particle makes 8,077,200,000 collisions per second. 4. The laws of the diffusion of gases, as established by Professor Graham, Jr., are deduced from this theory, and the absolute rate of diffusion through an opening can be calculated. The author intends to apply his mathematical methods to the explanation on this hypothesis of the propagation of sound, and expects some light on the mysterious question of the absolute number of such particles in a given mass.

COLOR-BLINDNESS.

If there is one infirmity or defect of those five senses with which we are most of us blest which more than any other attracts sympathy and claims compassionate consideration, it is blindness, — an inability to know what is beautiful in form or in color, to appreciate light, or to recognize and comprehend the varying features of our fellow-men, — a perpetual darkness in the midst of a world of light, — a total exclusion from the readiest, pleasantest, and most available means of acquiring ideas.

And yet who would suppose that there exists, and is tolerably common, a partial blindness, which has hardly been described as a defect for more than half a century, and of which it may be said, even now, that most of those who suffer from it are not only themselves ignorant of the fact, but those about them can hardly be induced to believe it. The unhappy victims of this partial blindness (which is real and physical, not moral) are at great pains in learning what to them are minute distinctions of tint, although to the rest of the world they are differences of color of the most marked kind, and, after all, they only obtain the credit of unusual stupidity or careless inattention, in reward for their exertions and in sympathy for their visual defect. We allude to a peculiarity of vision which first attracted notice in the case of the celebrated propounder of the atomic theory in chemistry, the late Dr. Dalton, of Manchester, who, on endeavoring to find some object to compare in color with his scarlet robe of doctor of laws, when at Cambridge, could hit on nothing which better agreed with it than the foliage of the adjacent trees, and who, to match his drab coat, — for our learned doctor was of the Society of Friends, — might possibly have selected crimson continuations, as the quietest and nearest match the pattern-book of his tailor exhibited.

An explanation of this curious defect will be worth listening to, the more so as one of our most eminent philosophers, Sir John Herschel, has recently made a few remarks on the subject, directing attention at the same time to other little known but not unimportant phenomena of color, which bear upon and help to explain it.

It is known that white light consists of the admixture of colored rays in certain proportions, and that the beautiful prismatic colors seen in the rainbow are produced by the different degree in which the various rays of color are bent when passing from one transparent substance into another of different density. Thus, when a small group of color-rays, forming a single pencil or beam of white sunlight, passes into and through the atmosphere during a partial shower, and falls on a drop of rain, it is first bent aside on entering the drop, then reflected from the inside surface at the back of the drop, and ultimately emerges in an opposite direction to its original one. During these changes, however, although all the color-rays forming the

white pencil have been bent, each has been bent at a different angle, — the red most, and the blue least. When, therefore, they come out of the drop, the red rays are quite separated from the blue, and when the beam reaches its destination, the various colors enter the eye separately, forming a line of variously colored light, the upper part red and the lower part blue, instead of a mere point of white light, as the ray would have appeared if seen before it entered the drop. The eye naturally refers each part of the ray to the place from whence it appears to come, and thus, with a number of drops falling and the sun not obscured, a rainbow is seen, which represents part of a number of concentric circular lines of color, the outermost of which is red, the innermost violet, and the intermediate ones we respectively name orange, yellow, green, blue, and indigo.

It has also been found, by careful experiment, that these are not all pure colors, most of them being mixtures of some few that are really primitive and pure, and necessarily belong to solar light. It is these, mixed in due proportion, which make up ordinary white light, which is the only kind seen when the sun's rays have not undergone this sort of decomposition, or separation into elements. The actual primitive colors are generally supposed to be red, yellow, and blue, and much theoretical as well as practical discussion has arisen as to how these require to be mixed, what proportion they bear to each other in their power of impressing the human eye, and many other matters, for which we must refer to Mr. Field, Mr. Owen Jones, and others, who have studied the subject and applied it.

In a general way it is found convenient to remember, or rather to assume, that three parts of red, five parts of yellow, and eight parts of blue, form together white, and, therefore, that the pencil of white light contains three rays of red, five of yellow, and eight of blue. To produce the other prismatic colors, we must mix red with a little yellow to form orange; yellow with some blue to form green; much blue with a little red to form indigo, and a little blue with some red to form violet. In performing experiments on color it is convenient, instead of a drop of water, to substitute a prism of glass in decomposing the rays of light. We may thus produce at will a convenient image, called a *prismatic spectrum*, which, when thrown on a wall, is a broad band of colored lights, having all the tints of the rainbow in the same order. Looking at this image, the red is at the top and the violet at the bottom, and it may be asked, How does the red get amongst the blue to form violet, if the red rays are bent up to the top of the spectrum? The answer is, that a quantity of white light not decomposed, and a part of all the color-rays, reach all parts of the spectrum, however carefully it is sheltered, but that so many more red rays get to the top, so many more of the yellow to the middle, and so many more blue to where that color appears most brilliant, that these are seen nearly pure, whilst where the red and yellow or yellow and blue mix they produce distinct kinds of color, and where the blue at the bottom is faint, and some of those red rays fall that do not reach the red part of the spectrum, the violet is produced. In point of fact, therefore, all the colors of the spectrum, as seen, are mixtures of pure colors with white light, while all but red are mixtures of other pure colors with some red and some yellow, as well as white. Primitive and pure colors, therefore, are not obtained in the spectrum, and a question has arisen as to which really deserve to be called pure; Dr. Young upholding green against yellow, and even regarding violet as primitive, and blue a mixed color. A consideration of

the results of this theory would lead us farther than is necessary for the purpose we have now in view.

We also find philosophers now-a-days calmly discussing a question which most people considered settled very long ago, namely, whether blue and yellow together really make green.

It is of no use for the artist to lift up his eyes with astonishment at any one being so insane as to question so generally admitted a statement. In vain does he point to his pictures, in which his greens have been actually so produced. The strict photologist at once puts him down, by informing him that he knows little or nothing of the real state of the case: his (the artist's) colors are *negative*, or hues of more or less complete darkness; whereas in nature the color question is to be decided by *positive* colors, or hues in which all the light used is of one kind. The meaning of this will be best understood by an example: When a ray of white light falls on a green leaf, part of the ray is absorbed and part reflected, and the object is therefore only seen with the part that is reflected. That which is absorbed consists of some of each of the color-rays, and the resulting reflected light is nothing more than a mixture of what remains after this partial absorption. The green we see consists of the original white light deprived of a portion of its rays. It is not a pure and absolute green, but only a residual group of colored rays, and thus in so far the green color is *negative*, or consists of rays not absorbed. It is therefore *partial darkness*, and not absolute light. If, however, on the other hand, a ray of white light is passed through a transparent medium (*e. g.*, some chemical salt) which has the property of entirely absorbing all but one or more of the color-rays, and no part of the remainder, then all the light that passes through this medium is of the one color, or a mixture of the several colors that pass; and if such light is thrown on a *white* ground, the reflected color will be *positive*, and not negative, and is far purer as well as brighter than the color obtained in the other way. It has been found by actual experiment that when positive blue, thus obtained, is thrown on positive yellow, the resulting reflected color bears no resemblance to green. Sir John Herschel considers that whether green is a primitive color—in other words, whether we really have three or four primitive colors—remains yet an open question.

It was necessary to explain these matters about color before directly referring to the subject of this paper, namely, blindness to certain color-rays. It should also be clearly understood that the persons subject to this peculiar condition of vision have not, necessarily, any mechanical or optical defect in the eye, as an optical instrument, which may be strong or weak, long-sighted or short-sighted, quite independently of it. Color-blindness does not in any way interfere with the ordinary requirements of vision, nor is there the smallest reason to imagine that it can get worse by neglect, or admit of any improvement by education or treatment.

Assuming that persons of ordinary vision see three simple colors, red, yellow, and blue, and that all the rest of the colors are mixtures of these with each other and with white light, let us try to picture to ourselves what must be the visual condition of a person who is unable to recognize certain rays; and as it appears that there is but one kind of color-blindness known, we will assume that the person is unable to recognize those rays of white light which consist of pure red and nothing else. In other words, let us investigate the sensations of a person blind so far only as pure red is concerned.

All visible objects either reflect the same kind of light as that which falls on them, absorbing part and reflecting the rest, or else they absorb more of some color-rays than others, and reflect only a negative tint, made up of a mixture of all the color-rays not absorbed. To a color-blind person, the mixed light, as it proceeds from the sun, is probably white, as seen by those having perfect vision; for, as we have explained already, positive blue and yellow (the color-rays when red is excluded) do not make green, and the absence of the red ray is likely to produce only a slight darkening effect. So far, then, there is no difference. But how must it be with regard to color?

Bearing in mind what has been said above, it is evident that in withdrawing the red rays from the spectrum, we affect all the colors. The orange is no longer red and yellow, but darkened yellow; the yellow is purer, the green is quite distinct, the blue purer, and the indigo and violet no longer red and blue, but blue mingled with more or less of darkness, the violet being the darkest, as containing least blue in proportion to red, while the red part itself, though not seen as a color, is not absolutely black, inasmuch as its part of the spectrum is faintly colored with the few mixed rays of blue and yellow and white that escape from their proper place. The red then ought to be seen as a gray neutral tint, the orange a dingy yellow, the indigo a dirty indigo, and the violet a sickly, disagreeable tint of pale blue, darkened considerably with black and gray.

Next, let us take the case of an intelligent person affected with color-blindness, but who is not yet aware of the fact. He has been taught from childhood that certain shades, some darker and some brighter, but all of neutral tint, and not really presenting to him color at all, are to be called by various names,—scarlet, crimson, pale red, dark red, bright red, dark green, dark purple, brown, and others. With all these he can only associate an idea of gray; nor can he possibly know that any one else sees more than he does. Having been taught the names they are called by, he remembers the names, with more or less accuracy, and thus passes muster. There is a real difference of tint, because each of these colors consists of more or less blue, yellow, and white, mixed with the red; and our friend is enabled to recognize and name them, more or less correctly, according to his acuteness of perception and accuracy of memory.

If we desire to experiment on such a person, we must ask no names whatever, but simply place before him a number of similar objects differently colored. Taking, for example, skeins of colored wools, let us select a complete series of shades of tint, from red, through yellow and green to violet, and request him to arrange them as well as he is able, placing the darkest shades first, and putting those tints together that are most like each other. It is curious then to watch the progress of the arrangement. In a case lately tried by the writer of this article, the color-blind person first threw aside at once a particular shade of pale green as undoubted white, and then several dark blues, dark reds, dark greens, and browns, were put together as black. The yellows and pure blues were placed correctly, as far as name was concerned, by arranging several shades in order of brightness,—but the order was very different from that which another person would have selected. The greens were grouped, some with yellows, and some with blues.

The colors in this experiment were all negative and impure; but we may also obtain something like the same result with positive color, transmitted by the aid of polarized light through plates of mica. In a case of this kind described by Sir J. Herschel, the only colors seen were blue and yellow,

while pale pinks and greens were regarded as cloudy white, fine pink as very pale blue, and crimson as blue; white red, ruddy pink, and brick red were all yellows, and fine pink blue, with much yellow. Dark shades of red, blue, or brown were considered as merely dark, no color being recognized.

The account of Dr. Dalton's own peculiarity of vision, by himself, offers considerable interest. He says, speaking of flowers: "With respect to colors that were white, yellow, or green, I readily assented to the appropriate term; blue, purple, pink, and crimson appeared rather less distinguishable, being, according to my idea, all referable to blue. I have often seriously asked a person whether a flower was blue or pink, but was generally considered to be in jest." He goes on further to say, as the result of his experience: "1st. In the solar spectrum three colors appear, — yellow, blue, and purple. The two former make a contrast; the two latter seem to differ more in degree than in kind. 2d. Pink appears by daylight to be sky-blue a little faded; by candle-light it assumes an orange or yellowish appearance, which forms a strong contrast to blue. 3d. Crimson appears muddy blue by day, and crimson woollen yarn is much the same as dark blue. 4th. Red and scarlet have a more vivid and flaming appearance by candle-light than by daylight" (owing, probably, to the quantity of yellow light thrown upon them).

As anecdotes concerning this curious defect of color-vision, we may quote also the following: "All crimsons appear to me (Dr. Dalton) to be chiefly of dark blue, but many of them have a strong tinge of dark brown. I have seen specimens of *crimson claret* and *mud* which were very nearly alike. Crimson has a grave appearance, being the reverse of every showy or splendid color." Again: "The color of a florid complexion appears to me that of a dull, opaque, blackish blue upon a white ground. Dilute black ink upon white paper gives a color much resembling that of a florid complexion. It has no resemblance to the color of blood." We have a detailed account of the case of a young Swiss who did not perceive any great difference between the color of the leaf and that of the ripe fruit of the cherry, and who confounded the color of a sea-green paper with the scarlet of a riband placed close to it. The flower of the rose seemed to him greenish blue, and the ash-gray color of quicklime light green. On a very careful comparison of polarized light by the same individual, the blue, white, and yellow were seen correctly, but the purple, lilac, and brown were confounded with red and blue. There was in this case a remarkable difference noticed according to the nature and quantity of light employed; and as the lad seemed a remarkably favorable example of the defect, the following curious experiment was tried. A human head was painted, and shown to the color-blind person, the hair and eyebrows being white, the flesh brownish, the lips and cheeks green. When asked what he thought of this head, the reply was, that it appeared natural, but that the hair was covered with a nearly white cap, and the carnation of the cheeks was that of a person heated by a long walk.

There is an interesting account in the *Philosophical Transactions for* 1859 (p. 325), which well illustrates the ideas entertained by persons in this condition with regard to their own state. The author, Mr. W. Pole, a well-known civil engineer, thus described his case: "I was about eight years old, when the mistaking of a piece of red cloth for a green leaf betrayed the existence of some peculiarity in my ideas of color; and as I grew older

continued errors of a similar kind led my friends to suspect that my eyesight was defective; but I myself could not comprehend this, insisting that I saw colors clearly enough, and only mistook their names.

"I was articled to a civil engineer, and had to go through many years' practice in making drawings of the kind connected with this profession. These are frequently colored, and I recollect often being obliged to ask, in copying a drawing, what colors I ought to use; but these difficulties left no permanent impression, and up to a mature age I had no suspicion that my vision was different from that of other people. I frequently made mistakes, and noticed many circumstances in regard to colors which temporarily perplexed me. I recollect, in particular, having wondered why the beautiful rose light of sunset on the Alps, which threw my friends into raptures, seemed all a delusion to me. I still, however, adhered to my first opinion, that I was only at fault in regard to the names of colors, and not as to the idea of them; and this opinion was strengthened by observing that the persons who were attempting to point out my mistakes often disputed among themselves as to what certain hues of color ought to be called." Mr. Pole adds that he was nearly thirty years of age when a glaring blunder obliged him to investigate his case closely, and led to the conclusion that he was really color-blind.

All color-blind persons do not seem to make exactly the same mistakes, or see colors in the same way; and there are, no doubt, many minor defects in appreciating, remembering, or comparing colors which are sufficiently common, and which may be superadded to the true defect,—that of the optic being insensible to the stimulus of pure red light. It has been asserted by Dr. Wilson, the author of an elaborate work on the subject, that as large a proportion as one person in every eighteen is color-blind in some marked degree, and that one in every fifty-five confounds red with green. Certainly the number is large, for every inquiry brings out several cases; but, as Sir John Herschel remarks, were the average anything like this, it seems inconceivable that the existence of the defect should not be one of vulgar notoriety, or that it should strike almost all uneducated persons, when told of it, as something approaching to absurdity. He also remarks, that if one soldier out of every fifty-five were unable to distinguish a scarlet coat from green grass, the result would involve grave inconveniences, that must have attracted notice. Perhaps the fact that a difference of tint is recognized, although the eye of the color-blind person does not appreciate any difference of color, when red, green, and other colors are compared together, and that every one is educated to call certain things by certain names, whether he understands the true meaning of the name or not, may help to explain both the slowness of the defective sight to discover its own peculiarity, and the unwillingness of the person of ordinary vision to admit that his neighbor really does not see as red what he agrees to call red.

There is, however, another consideration that this curious subject leads to. It is known that out of every 10,000 rays issuing from the sun, and penetrating space at the calculated rate of 200,000 miles in each second of time, about one-fifth part is altogether lost and absorbed in passing through the atmosphere, and never reaches the outer envelop of the human eye. It is also known that of the rays that proceed from the sun, some produce light, some heat, and some a peculiar kind of chemical action to which the marvels of photography are due. Of these, only the light rays are appreciated specially by the eye, although the others are certainly quite as important in

preserving life and carrying on the business of the world. Who can tell whether, in addition to the rays of colored light that together form a beam of white light, four-fifths of which only pass through the atmosphere, there may not have emanated from the sun other rays altogether absorbed and lost; or whether, in entering the human eye, or being received on the retina at the back of the eye, or made sensible by the optic nerve, there may not have been losses and absorptions sufficient to shut out from us, who enjoy what we call perfect vision, some other sources of information? How, in a word, do we who see clearly only three or four colors, and their various combinations, together with their combined white light, — how do we know that to beings otherwise organized, the heat or chemical rays, or others we are not aware of, may not give distinct optical impressions? We may meet one person whose sense of hearing is sufficiently acute to enable him to hear plainly the shrill night-cry of the bat, often totally inaudible, while his friend and daily companion cannot perhaps distinguish the noise of the grasshopper or the croaking of frogs, and yet neither of these differs sufficiently from the generality of mankind to attract attention, and both may pass through life without finding out their differences in organization, or knowing that the sense of hearing of either is peculiar. So undoubtedly it is with light. There may be some endowed with visual powers extraordinarily acute, seeing clearly what is generally altogether invisible; and this may have reference to light generally, or to any of the various parts of which a complete sunbeam is composed. Such persons may habitually see what few others ever see, and yet be altogether unaware of their powers, as the rest of the world would be of their own deficiency.

The case of the color-blind person is the converse. He sees, it is true, no green in the fields, or on the trees; no shade of pink mantling in the countenance, no brilliant scarlet in the geranium flower; but still he talks of these things as if he saw them, *and he believes he does see them*, until by a long process of investigation he finds out that the idea he receives from them is very different from that received by his fellows. He often, however, lives on for years, and many have certainly lived out their lives, without guessing at their deficiency.

These results of physical defects of certain kinds remaining totally unknown, either to the subject of them or his friends, even when all are educated and intelligent, are certainly very curious; but it will readily be seen that they are inevitable in the present development of our faculties. In almost everything, whether moral or intellectual, we measure our fellows by our own standard. He whose faculties are powerful, and whose intellect is clear, looks over the cloud that hovers over lower natures, and wonders why they, too, will not see truth and right as he sees them. Those, on the other hand, who dwell below, among the mists of error and the trammels of prejudice, will not believe that their neighbor, intellectually loftier, sees clearly over the fog and malaria of their daily atmosphere.

In taking leave of the question of color-blindness, it should be mentioned that hitherto no case has been recorded in which this defect extends to any other ray than the red. There seems no reason for this, and possibly, if they were looked for, cases might be found in which the insensibility of the optic nerve had reference to the blue instead of the red ray,— the least, instead of the most, refrangible part of the beam of light. It would also be well worth the trial if those who have any reason to suppose that they enjoy a superiority of vision would determine by actual experiment the extent of their unusual

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powers, and learn whether they refer to an optical appreciation of the chemical or heat rays, or show any modification of the solar spectrum by enlargement or otherwise.

Lastly, it would be well, when children show an unusual difficulty in describing colors, to try, by some such experiments as those here related, whether any defect of color-blindness exists or not. It would clearly be undesirable that such children as have this defect should waste time in learning accomplishments or professions which they must always be unable to practise. They, their parents, and teachers may thus be saved some of that disappointment which is always experienced when presumed tastes and talents are cultivated or forced contrary to the natural powers of the individual. It must clearly be hopeless to endeavor to obtain good taste in colors, when most of the colors themselves are not seen at all, or are so recognized as to present appearances altogether different from those seen by the rest of the world.

THE CHAMELEON'S CHANGE OF COLOR.

In 1827, the celebrated Dutch anatomist, Vrolik, ascertained the fact of the influence exercised by light on the color of these animals; and he observed also that there was a constant succession, or oscillation, of colors. Four years later, his countryman, Van der Hooven, executed the plan of reproducing in five different plates the changes of color he observed. These show that the fundamental color of the animal persists under all the variations which may take place in parts. He observes that the median line, from the chin downwards, is always of one yellow tint. In his opinion the changes of color are due to a pigment underneath the skin. This idea was taken up by Milne-Edwards, who had two chameleons with different shades of color: the one presenting violet-spots on its flanks; the other, green spots of varying shade. He observed that the change of color was quite independent of the animal's swelling himself out or not. On removing a strip of skin from the dead animal, and placing it under a microscope, he observed that the darkest color was beneath the tubercles, and that in these spots the yellow color was masked, but not replaced; it still existed, although the violet spots beneath it rendered it invisible. Two pigments therefore are possessed by the chameleon: one, the yellow pigment, being distributed over the surface; the other, the violet pigment, being distributed underneath the former, and only becoming visible under certain circumstances, such as the stimulus of light. Milne-Edwards found that, on stimulating the yellow spots with alcohol or acids, they became violet; on stimulating the violet spots they became yellow.

And thus, after many centuries of easy fable and reiterated assumptions, the more arduous but more fruitful methods of exact science gained the key to the whole mystery. But only the key. Milne-Edwards had explained the yellow and black hues, but had not explained the others. That was reserved for Prof. Bruecke, of Vienna. He has succeeded to the satisfaction of men of science; but as it would require more technical knowledge to understand his explanation than can be expected of the ordinary reader, and would lead us to a length beyond our limits, we will merely add, that his observations show that the chameleon has his own colors, and does not borrow them from surrounding objects; if he sometimes shows more of one than of another, it is not that, like a negro maiden blushing, the emotions of his soul are eloquent on his surface, but simply that the rays of light act upon his skin. After

which explanation, it is hoped that we shall hear no more scandals about this much abused Saurian.

CHROMEIDOSCOPE.

Under this name a new form of kaleidoscope has recently been brought out in England. The objects viewed, instead of being bits of colored glass, etc., are patches of floss silk of various colors, arranged on a spindle, capable of being drawn in and out, and rotated, so as to make endless changes. The effect is very pretty, and, as any figure can be reproduced and kept stationary, the instrument is likely to be of use to designers for manufactured goods, as well as forming a pleasing optical toy.

THE DEBUSSCOPE.

This name has been given to a recent French invention, which consists of two silvered plates, highly polished and of great reflective power, placed together in a frame-work of cardboard or wood, at an angle of seventy degrees. On being placed before a small picture, a design of any kind, no matter how rough, or whether good or bad, the debusscope will reflect the portion immediately under the eye, on all sides, forming the most beautiful designs; and, by being slowly moved over the picture, will form new designs to any extent. The instrument gives the design in such a manner that it can be made stationary at pleasure, until copied. It is, therefore, an inexhaustible treasure to draughtsmen and others. Setting aside the utility of the debusscope altogether, it can be made the means of gratification in the drawing-room, and, doubtless, will soon assume its proper place along with the microscope and stereoscope, as a source of amusement.

LOSS OF LIGHT BY GLASS SHADES.

A correspondent (W. King) of the London *Journal of Gas-lighting* gives the following table, made up from a series of experiments, of the amount of light lost by various shades: —

Description of shade.	Loss of light.
Clear glass, ...	10.67 per cent.
Ground glass (entire surface ground), .	29.48 "
Smooth opal, ...	52.83 "
Ground opal, ...	55.85 "
Ground opal, ornamented with painted figures, the figures intervening between the burner and the photometer screen,	73.98 "

As the large amount of light lost by the use of a clear glass shade excited some surprise, a sheet of common window glass was placed between the burner and the photometer screen, when it was found that 9.34 per cent of the light was intercepted, thus confirming the result obtained by the employment of a shade of clear glass. The shades were selected from a large number, and great pains taken to obtain an average specimen of each kind.

The result of a series of comparative experiments on the same subject

has been also communicated to Silliman's Journal, November, 1860, by F. H. Storer, Esq., of Boston. Instead of lamp shades, however, flat sheets of glass (ordinary window-panes), six by eight inches, were fitted to a rack of blackened wire, which was fastened to a photometer bar (one hundred inches long), at a distance of three feet from the gas-light. The illuminating power of the gas used was equal to sixteen candles, consuming, by calculation, one hundred and twenty grains of spermaceti per hour. The results obtained were as follows:

Description of glass.	Thickness of glass.		Loss of light.
Thick English plate, . . .	$\frac{1}{3}$ of an inch,		6.15 per cent.
Crystal plate, ...	$\frac{1}{8}$ "		8.61 "
English crown, ...	$\frac{1}{8}$ "		13.08 "
"Double English," window-glass,	$\frac{1}{8}$ "		9.39 "
"Double German,"[1] " "	$\frac{1}{8}$ "		13.00 "
"Single German,"[1] " "	$\frac{1}{16}$ "		4.27 "
Double German, ground,[2] . .	$\frac{1}{8}$ "		62.34 "
Single German, ground,[2] . .	$\frac{1}{16}$ "		65.75 "
Berkshire (Mass.), ground,[2] . .	$\frac{1}{16}$ "		62.74 "
Berkshire enamelled, *i. e.*, ground only upon portions of its surface, — small figure,	$\frac{1}{16}$ "		51.23 "
"Orange-colored" window-glass,	$\frac{1}{16}$	As used for church windows, etc.	84.48 "
"Purple" " " "	$\frac{1}{8}$		85 11 "
"Ruby" " " "	$\frac{1}{16}$		89.62 "
"Green" " " "	$\frac{1}{16}$		81.97 "
A porcelain transparency (Tyrolese Hunter), ...	$\frac{1}{16}$ "		97.68 "

"The term 'loss of light,'" says Mr. Storer, "does not at first seem to be strictly appropriate, for a very considerable portion of the light not transmitted by a glass shade might be reflected against the walls of the apartment in which the lamp is burning, and thus aid in the general illumination of the room. The meaning of the expression is, however, perfectly evident; and there can be no doubt that the numbers given express as accurately as the circumstances of the case admit the actual diminution in the amount of light falling, for example, upon the pages of a book held near its source, which would be occasioned by the interposition of the shades enumerated in the tables."

In commenting upon this subject, the editor of Silliman's Journal further remarks: —

1 Among the Boston dealers, the term German is applied to glasses of Belgian manufacture.

2 The enormous resistance to the passage of light which is offered by ground glass is certainly worthy the attention of those using it for windows, etc.

The discrepancy between Mr. King's results and my own, as regards ground glass, may perhaps be owing to the fact that the window glass used by myself was *more coarsely ground* than the lamp shades employed by him.

We cannot doubt that the great loss of light proved by the experiments above given, is to be, in part at least, accounted for by the conversion of a portion of the light into heat,— an effect perfectly in harmony with the theory of transverse vibrations as applied to explain the phenomena of polarization of heat. On this theory, heat and light are different effects produced by one and the same cause, and they differ physically only in the rapidity and amplitude of their vibrations. The screen through which the vibrations of light are propagated serves to diminish, first the rapidity of the vibrations requisite to produce the most refrangible rays, and in proportion as the transparency of the screen is diminished by any cause, inherent or superficial, this arrest becomes more and more complete. As the more rapid ethereal vibrations have probably the least amplitude, we infer from analogy in sound-waves, that as waves of least intensity have the greatest amplitude, so with the luminiferous ether the extreme red has but little brilliancy. Hence the loss of light from polished screens is small compared with that observed in screens of opaline or roughened glass. It would be instructive to examine the spectrum obtained from a pencil of rays under each of the cases given, by means of a sulphide of carbon prism.

The subject of absorption of light by screens has long since been carefully examined by Bouguer. By a photometric method essentially like Rumford's, Bouguer measured the loss of light in the beam of a candle compared with a flambeau, and also with the light of full-moon, in passing through sixteen thicknesses of common window-glass having a united thickness of 21·43 millimetres = ·85 inch. The mean loss of light shown by these trials was as 247 : 1, or over ninety-nine per cent of the whole quantity.

Six plates of the purest mirror plate glass, having a united thickness of 15·128 millimetres, diminished the light in the ratio of 10 to 3, occasioning a loss of about seventy per cent of diffuse daylight. A mass of very pure glass, about three inches thick, diminished the light only about half the latter amount, owing to its being a single mass, and not cut up into many planes.

He also measured the absorbing power of sea-water for light, and found, as the results of experiments made in France, and of observations also in the torrid zone, that at the depth of three hundred and eleven French feet the light of the sun would be equal only to that of the full moon, and at the depth of six hundred and seventy-nine feet would wholly disappear. He estimates the transparency of the air as four thousand five hundred and seventy-five times greater than that of sea-water; and from the properties of a logarithmic curve (which he calls *gradulucique*), whose functions he had determined experimentally, he seeks to fix the outer limits of the atmosphere.

ON A PROBABLE MEANS OF RENDERING VISIBLE THE CIRCULATION IN THE EYE.

The following article is communicated to *Silliman's Journal* by Professor Ogden W. Rood, of the Troy (N. Y.) University: —

Some time ago, while looking at a bright sky through three plates of cobalt-glass, I saw with astonishment that the field of view was filled with, and traversed in all directions by, small bodies resembling animalcules. They were seen on the blue field as yellowish spots, and always appeared elongated in the direction of their motion, which was, as a general thing, tolerably uniform. The same result was obtained by experimenting upon the eyes of a number of persons. Convex lenses of various foci, from three

inches to one-half inch, were now held before the eyes, so as to give the blue light various degrees of convergence and divergence, without in the least altering the appearance of the moving bodies; this seemed to indicate that their locality was in the retina or in its immediate neighborhood. A position near the axis of vision was selected, and observed, when it was found that these bodies in traversing this spot always pursued the same direction and path, disappearing at the same point; other positions near the axis gave like results.

This would seem to preclude the possibility of the moving bodies being animalcules swimming in the humor of the eye; the most probable remaining supposition is, that they are blood corpuscles circulating in the retina or in its immediate neighborhood. The apparent diameter of these bodies when seen projected on a window six feet distant may be about $\frac{1}{20}$ of an inch, which corresponds to about $\frac{1}{1600}$ of an inch on the retina. The average diameter of the blood globules is $\frac{1}{3200}$ of an inch, but taking into account the fact that the shadows of the moving bodies are not well defined, the correspondence may be considered pretty satisfactory.

The question now arises as to the manner in which the blue glass renders the circulation visible; for these moving shadows cannot be seen with distinctness through red, orange, yellow, green, nor even purple, media; they are, on the other hand, well shown by a certain thickness of a solution of the cupro-sulphate of ammonia. Yellow solutions, when combined with the blue glass or blue solutions, render the circulation invisible, and it does not reappear till the yellow solution has been made so dilute as barely to preserve a yellow tint, and to transmit the spectrum almost unaltered. This shows that the indigo and violet rays are principally concerned in the production of this appearance; but that it cannot be attributed to fluorescent properties in the blood discs is indicated by the fact that the circulation can be seen through a considerable thickness of crown glass, through an infusion of red sanders wood mixed with ammonia, as well as through a solution of the bisulphate of quinine.

The only explanation that has occurred to me as being probable is the following: the blood discs are yellow, and consequently opaque, to a great extent, to the indigo and violet rays; they would, therefore, in passing before the retina, cast shadows on it; now, the retina being already strongly impressed with blue light, that portion of it which was momentarily protected from the action of this light would experience the complementary sensation,—or would see, instead of a moving shadow, a yellowish moving streak. This explains, also, why the appearance is not seen with any distinctness in red, orange, yellow, or green light, for yellow media are, to a great extent, transparent to all their rays, and therefore fail to cast shadows. These observations, if new, may be of some interest to those engaged in the study of the physiology of the eye.

ON OUR INABILITY FROM THE RETINAL IMPRESSION ALONE TO DETERMINE WHICH RETINA IS IMPRESSED.—BY PROFESSOR WILLIAM B. ROGERS.

Although on first view it might be supposed that an impression made in either eye must necessarily be accompanied by a mental reference to the particular organ impressed, it will be seen from the following simple experi-

ments that the impression of itself is not essentially suggestive of the special retinal surface on which it is received.

Exp. 1. Let a short tube of black pasteboard, one-fifth of an inch in diameter, be fixed in a hole in the centre of a large sheet of the same material. Hold the sheet a few inches before the face of a second person, and between him and a bright window, moving it to and fro until the bright circular aperture of the tube is brought directly in front of one of the eyes, suppose the left eye; and let him fix his attention upon the sky or cloud to which the tube is directed. He will feel as if the impression or image of the hole belongs equally to both eyes, and will be unable to determine which of them really receives the light.

Exp. 2. Similar results may be obtained by rolling half a sheet of letter paper into a tube, of about one inch in diameter, and holding it before and a little in advance of one eye, while both are directed to a white wall some feet distant. Keeping the view fixed upon the wall, there will be seen upon its surface a circular image of the remote aperture of the tube. This, as we look intently at it, will appear as if seen equally by both eyes, occupying a midway position between them. If now the eyes be converged to some point nearer than the end of the tube, the circular image will appear against the side of the tube, giving the impression that it is seen by the eye which is remote from the tube, and is, at the same time, directed towards the outside. For the complete success of this experiment, the wall should be only moderately bright, and but little light should fall on the exterior of the tube next the uncovered eye.

Exp. 3. Let two tubes of stiff paper, each one inch in diameter and six inches long, be held close to the two eyes in a converging direction so that the outer ends may touch each other. Then directing the view through them to a white wall, at a short distance, the observer will see the two tubes as one, with a single circular opening clearly marked out on the wall. If now a small object, as the end of the little finger, be brought near and in front of one of the tubes, it will take its place within this circle, and will seem to be equally an object of vision to both eyes, so that the observer will be wholly unable to decide before which eye it is actually placed.

Let the observer next direct his view to a very remote object, — as the sky, — seen through the window, still retaining the previous adjustment of the tubes. He will now see two circles, continuing separate as long as he keeps his eyes fixed on the distant surface; and if the finger be held up, as before, in front of one of the tubes, it will appear within the circle which is in front of the other eye, thus causing the impression on the right eye to be apparently transposed to the left, and *vice versa.*

Exp. 4. Fasten a small disc of white paper on a slip of black pasteboard, of the size suitable for a stereoscope, and place this in the instrument so that the white spot shall be centrally in front of one of the glasses. To a person not aware of the position of the spot, it will appear in the stereoscope as if equally in view to both eyes, and he will be entirely unable to decide on which retina its picture is impressed. Indeed, properly considered, the spot does not appear directly in front of either eye, but is seen at the intersection of the optic axes, in the medial or binocular direction between the two.

Let the spot be now moved toward the right side, but still within the range of the left eye, and it will seem to be before the right eye rather than the left. Shift it into the right compartment, but not far from the dividing line, and it will appear as if seen chiefly by the left eye; and, finally, bring to it

the middle of the right compartment, and it will seem as at first to belong equally to both eyes.[1]

Referring to the results observed in the above experiments, when the object is directly in front of either eye, it may be concluded that the mere retinal impression on either eye is unaccompanied by any consciousness of the special surface impressed; and that the formation of the visual perception appertains to that part of the optical apparatus near or within the brain, which belongs in common to both eyes.

These observations show moreover that the perceived direction is just as truly normal to the central part of the retina which has received no light, as to that of the retina on which the white spot has been painted. Indeed, as before indicated, it is normal to neither, but is felt to be in the middle line between the two; that is, in the binocular direction. It need scarcely be added, that this conclusion is at variance with the law of visible direction, maintained by Brewster, which requires that the apparent direction of an object shall in all cases be normal to the part of the retina impressed.

The reference of the object, in certain cases above noticed (parts of 1, 2, and 4), to one eye chiefly, and that the eye from which it is actually hidden, is accounted for by the direction in which the other eye receives the light. As this direction, in the case of the left eye, for instance, would be decidedly toward the field of view of the right eye, it would at once suggest the place of the object as somewhere before that eye; and so, when the object is actually before the right eye, but in a position towards the left, it would excite the idea of an object somewhere before the left eye. As the retinal picture alone gives no indication of the particular eye in which it is formed, but only excites a visual consciousness common to both, the object in these cases will seem to be visible by both eyes, but chiefly by that before which the suggestion just mentioned would naturally place it.

Exp. 5. Thus if we place on the black slide of the stereoscope two spots, differing either in shape or color, one before each eye, we perceive them both in the middle or binocular direction, each seemingly visible in an equal degree to both eyes, the one being seen through or upon the other, according to the fitful attention or suggestion of the moment. A pleasing modification of this experiment is made by using two unequal white spots on the black slide, and interposing a green or other colored glass between one of them and the lens. The spot which appears colored will give as strongly the impression of being seen by both eyes as the white one, in spite of our knowledge of the position of the colored glass.

Exp. 6. To observe this effect satisfactorily, it is well to make the experiment in an apartment in which a single small lamp is placed at some distance from the spot on which we stand. Looking intently at the lamp, we bring the pencil before the face in such position as to give us an image on each side of the lamp, and then move the pencil toward the right until its left hand image seems to coincide in direction and position with the lamp, which appears to shine through, or to partially replace it. As we continue to look thus at the lamp, we have a clear impression that both lamp and pencil are equally visible to both eyes; and without some consideration of the previous

[1] The effect here described is one of a series of phenomena, which Dr. O. W. Holmes attributes to an *actual transfer* of impressions from one eye to the other, and which he proposes to explain by the hypothesis of reflex vision.

adjustment and motions we are unable to determine which is actually visible to the right and which to the left eye.

The same experiment furnishes also an incidental illustration of the principle of transposed visual reference, before alluded to. If, while the above adjustment is maintained, we contemplate the other image of the pencil, situated some distance to the right of the lamp, and endeavor to decide, from the mere visual impression, to which eye it appertains, we almost unfailingly refer to the right eye as that which most nearly fronts it; although obviously it belongs to the other, as will be found at once on closing either eye.

Where the eyes are externally very sensitive, any strong illumination of one as compared with the other will interfere with the effect above described, by referring the impression specially to the eye thus unduly excited. In such cases the observation is best made, in a moderately lighted room, by interposing the pencil between the eye and a vertical stripe on the wall.

Exp. 7. Recurring to experiment 2, in which, with a tube in front of one eye, we perceive a bright circle on the wall in the medial direction, we may obtain a pleasing illustration of the point now under consideration, by bringing a dark card or book, or even the hand, between the uncovered eye and the wall. The spot, instead of being intercepted, will appear as a perforation in the opaque screen.

Here, as in the case of the pencil and lamp, the bright circle and the screen are both optically referred to the intersection of the two lines of view. But the luminous circle almost or entirely obliterates the corresponding part of the screen. As the full view of the screen and its connections continually remind us that it is in front of the uncovered eye, we are led to refer the luminous circle seen as coincident with a part of it to the same eye, and thus to believe that we are looking through the screen with that eye. It is, however, not difficult, by intently regarding the luminous circle, so to counteract the force of this extraneous suggestion as to feel, even in this case, as if the circle were equally in view to both eyes.

These considerations explain very simply the experiment of the pseudodiascope described by Mr. Ward, of Manchester, which, like several of those above mentioned, is but an instance of the old observation of Da Vinci, that when we see behind a small opaque object presented near the eyes "it becomes as it were transparent." In making this experiment with a tube of paper supported between the thumb and fore-finger of the left hand, and held before the right eye, so that the back of the hand may be some inches in advance of the left eye, it will be noticed that the effect varies with the amount of convergence of the eyes, and that the bright perforation in the hand may or may not be referred to the left eye, according to the force of the accessory suggestion, or the intentness with which we fix our gaze upon the distant spot to which the axes are converged.

In conclusion, it may be remarked that the experiments which have been described are, for the most part, too obvious and familiar to have merited such a special notice, but for the peculiar and in some respects new interpretation which they have offered of many visual phenomena. Considered in this relation, we are, I think, entitled to conclude from them,

First, That the retinal impression of an object presented directly to either eye is accompanied by the feeling of a united visual act, and of itself gives no indication of the particular eye impressed. And,

Second, That the reference of the impression to one eye rather than the other is the result of collateral suggestion, which may either locate the image

in the eye that actually receives it, or may transpose it seemingly to the other, according to the particular conditions of the observation.— *Silliman's Journal.*

NEW APPLICATIONS OF PHOTOGRAPHY.

Sir Henry James, director of the Ordnance Survey of Great Britain, states, that by means of the application of photography to the reduction of maps in the Ordnance Survey office a saving of at least £35,000 has been effected. Formerly the reduction had been effected by the pentagraph, when the accuracy depended on the skill of the operator; now, by merely fixing a camera before a plan, it could be reduced to any scale desired, by an operation of a few minutes' duration, and with the greatest accuracy. The scales of the maps were ten and a half feet to the mile, twenty-five inches to the mile, six inches to the mile, and one inch to the mile. Maps could be reduced from the large scale to all the smaller ones by photography, except to the scale of one inch to the mile. Here it was found that photography was rather too accurate. The photograph thus reduced was found to be too much covered with details, so that they still had to employ the pentagraph in the last operation. The photographs of the maps, once taken, are transferred to a copper or zinc plate by a new process, called "photo-zincography," which is substantially as follows: Instead of printing the negative on ordinary printing paper, they employed tracing paper, washed over with a saturated solution of bi-chromate of potash and gum-water, and exposed to the action of light. This rendered the bi-chromate insoluble in water. The print was then placed face downwards on a metal plate, covered with lithographic ink. It was then washed to remove the portion not acted on by light, by dissolving away the bi-chromate of potash, when the printing was left, of a light brown color, in lithographic ink. This could be transferred to a copper plate, as a guide to the engraver, by placing it face downwards and burning it in; or, for zincographic purposes, by burnishing it down on a zinc plate and merely inking the plate with ordinary ink.

Application of Photography to the Ornamentation of Porcelain. — A patent has been recently granted in England to John Wyard, for the production of photographic images on plates of glass and porcelain, in such a way as to enable them to be permanently fixed by being burnt in with ceramic colors. The details of the process, which are of too technical a character to warrant insertion in this connection, are made public, and seem to promise a large measure of success.

On the Employment of Photography for the Determination of the Path and Velocities of Shooting Stars. — Professor J. H. Lane, in a communication to Silliman's Journal (July, 1860), suggests the employment of photography for the accurate determination of the path and velocity of a shooting star, with a view to the determination of its orbit. The general plan proposed for adoption by Prof. L. is as follows: In the first place, simple exposure of a highly sensitive photographic plate in a camera, at a given station, would give the apparent track of a meteor as seen by the observer at that station, and a pair of such records, made in two cameras at two stations, would give the track in absolute space. In the second place, if one of the two cameras were furnished with a mechanism by which equidistant points of time should be marked upon the track made in that camera, these points could be referred to the real path in space, and if both cameras were in like manner furnished, the two records would, to that extent, be a check upon each other, and serve

to reduce the limits of probable error. The device for marking time is an application of the revolving glass prism. Thus, immediately in front of the object-glass of the camera, a glass prism, of small angle and sufficient area to cover the entire aperture, is made to rotate at an accurately measured rate of say twenty-five revolutions per second. The prism may be replaced by an eccentric lens, or the object-glass itself may revolve on a slightly eccentric axis. The consequence will be that the image of a fixed star in any part of the field of view will traverse the circumference of a circle every twenty-fifth of a second, and the image of a shooting star will combine this motion with its motion of translation. If the photographic surface retain a visible impression of the looped curve or the waved curve which will thus be produced, then, neglecting for the present the small effects of optical distortion, the line drawn midway between the two straight or regularly curved lines between which the looped or waved curve oscillates, will represent the apparent track of the meteor, and the points where it intersects the looped or waved curve, if they be translated along this middle line through a space equal to the optical displacement of the meteoric image, will show the apparent place occupied by the meteor at points of time separated by the equal intervals of one-fiftieth of a second.

In the above statement I have supposed only a single camera, but it will probably be impossible in this way to command a sufficient extent of the heavens. A system of many cameras may, however, be formed, so arranged that their several optic axes shall cross in a common point *in front* of the object-glasses. The object-glasses may thus be approximated as closely as we can desire, and the several revolving prisms, or eccentric lenses, may have a common geared connection, and the backs of the cameras will be readily accessible for the renewal of plates.

The observer, after having made the necessary adjustments, will be charged with the sole duty of watching for meteors in the region covered by his system of cameras, and at the appearance of a meteor will touch a spring, so contrived as to cause the instant unveiling of all the cameras of the system, and on the extinction of the meteor will promptly replace the screen. The expense and trouble of the process will be certainly great, but will not be disproportionate to the importance of the object in view. Only let us have a photographic surface that will give a visible trace of the meteor's path, in the face of exposure to the light of the sky during the time of the meteor's visible flight, and then success, as regards the attainment of an accurate record, will be nearly certain, and we should not hesitate at the expense and trouble.

If, upon suitable trials made upon the fixed stars, and upon shooting stars themselves, we find ourselves in possession of sufficient photographic power, there is no reason why an organized system of observations should not be instituted. A moderate degree of accuracy in the absolute determination of the orbits, except when they make a near approach to the parabola, will be sufficient to answer all the questions of interest that will be likely to arise, upon which a knowledge of the orbits would have any bearing. Whether the November meteors, for instance, move through regions that would identify them with the Zodiacal light, according to the theory of the late Prof. Olmsted, is a question that would receive an absolute determination.

Charcoal Photographs and Photographic Enamels.—Indestructible charcoal photographs are now produced by exposing gelatine and bi-chromate of potash to the action of light, and then exposing the surface to steam. The

moisture softens the parts exposed to the light, so that when charcoal, or any other substance in impalpable powder, is sifted over the picture, it adheres to the softened parts of the picture. By the same process enamels may be produced direct from the camera, or otherwise, by sifting a metallic oxide over the gelatine on the enamel plate, and then heating in the furnace.

Application of Photography in construction of Micrometers. — The successful application of photography in the construction of micrometers has been made by Mr. Clarence Morfit, of the United States Assay Office, New York. It is merely the reduction of a large scale of exact dimensions and divisions to a definite size, suitable for microscopic instruments. A scale of ten inches divided into inches and tenths of an inch has been reduced in this manner to one-twentieth of an inch, thus making its smallest divisions equal to one two-thousandth part of an inch square. The method is simple, accurate, and economical. Moreover, the micrometer has the advantage of giving the exact measurement of the object in fractions of an inch, and at the same time determines the power of the microscope itself. — *Silliman's Journal.*

Adaptation of Machinery to Photography. — At a meeting of the American Photographical Society, Aug. 1860, Mr. G. H. Babcock called attention to a plan devised by Mr. Charles Fontayne, of Cincinnati, Ohio, for the adaptation of machinery to photographic printing. The general plan adopted was given as follows: —

A negative is fixed in a box, together with a sheet of prepared paper, and the latter exposed by automatic machinery to the condensed light of the sun passing through the negative. After each exposure the paper is traversed underneath the negative, to present a fresh surface for the succeeding impression. These motions, together with that of clamping the negative into close contact with the paper at the instant of exposure, are all performed by the operator simply turning a crank.

The rapidity of the process, as witnessed by Mr. Babcock, was stated to be at the rate of two hundred impressions per minute: — the photographic paper used is prepared by a process known only to the inventor.

If this invention is what it is represented to be, it opens a field for photography hitherto impracticable, in consequence of the time and expense of printing, as ordinarily practised. The illustrations for a book, having all the exquisite beauty and perfection of the photograph, may be turned out, by the use of this machine, with a rapidity wholly undreamed of, either in plate printing or lithography. The expense of engraving may be dispensed with, and the negative come direct from the artist's hands, drawn upon a prepared glass, from which, in the course of a few hours, the plates for a large edition may be printed, each one a perfect duplicate of the original drawing.

NEW METHOD OF COPYING ENGRAVINGS.

The London *Builder* gives the following rule for transferring engravings to white paper: — Place the engravings for a few seconds over the vapor of iodine. Dip a slip of white paper in a weak solution of starch, and, when dry, in a weak solution of oil of vitriol. When dry, lay a slip upon the engraving, and place them for a few minutes under the press. The engraving will thus be reproduced in all its delicacy and finish. The iodine has the property of fixing the black parts of the ink upon the engraving, and not on the white. This important discovery is yet in its infancy.

PANORAMIC STEREOSCOPES.

A patent has been recently taken out in England for a compound stereoscope, in which general or panoramic views of boulevards, streets, banks of rivers, and coast lines, monuments, sea views, etc., may be displayed by means of the gradual unrolling of one or more endless slides or bands carrying pictures. The distinctive feature of this invention is the adaptation to stereoscopes of one or more symmetrical, independent, movable, endless bands, on which are right and left hand halves, or corresponding parts of a stereoscopic panorama, or succession of pictures. The following is the construction of the instrument: The top thereof consists, as usual, of two lenses or eye-glasses, and the bottom thereof is mounted on a box containing rollers, on which are wound the before-mentioned endless slides or bands, on which are printed, pasted, or otherwise appropriately attached, the views or pictures in panoramic succession; also a train of wheelwork for setting the aforesaid bands in motion. The aforesaid bands and corresponding parts of the pictures thereon are brought under their respective eye-glasses upon a flat stage or platform over which the bands pass, so that, when set in motion, a panoramic stereoscopic view or picture is thus obtained. The description of the instrument is not very clear, we fear, to those who are not acquainted with the effect. We have, however, seen a similar instrument, and can assure our readers that nothing can surpass the beauty and interest of a beautiful stereoscopic panorama moving before the eyes of the spectator.—*Photographic News.*

PERSISTENT ACTIVITY OF LIGHT.

M. Moigno, editor of the *Cosmos*, communicates the following interesting facts in relation to the above subject:—

M. Niepce St. Victor exhibited to us a large tin tube, closed hermetically, and rendered inaccessible to all external agencies, except variations of temperature. He opened the tube in our presence, exposed, without unrolling it, a sheet of paper prepared with tartaric acid and isolated, which he had enclosed in the tube nearly a year before, poured on this sheet a few drops of nitrate of silver, and showed us that the nitrate was almost immediately blackened, exactly as it would have been in a strong light. It was impossible not to attribute this instantaneous effect to the persistent action of the light absorbed, a year ago, by the paper soaked in tartaric acid. If the experiment was more successful this time, although kept for a longer period, it was because of the much more perfect closure of the tube; and that which happened after a year would certainly happen after five or six years.

Again, M. Busk has established the following fact: Plunge a sheet of paper into a solution of a properly chosen acid, organic or inorganic, for example, acetic or tartaric acid; dry it; render it sensitive by the bath of nitrate of silver, and dry it again; place it in contact with the drawing which it is desired to reproduce for a half hour or more; then expose the paper to the sun's rays, and a negative image of the drawing will be seen, which may be fixed by washing with common water. It is not even necessary that the exposure to the light should take place at once; the paper may be preserved for several days, between two sheets of white paper, without losing its property of developing the latent image under the influence of the sun's rays. What is more difficult to explain, is, that there is no necessity of insolating or exposing to light the original picture.

To these facts, or to their interpretation, M. Thenard would oppose the following experiment which he has communicated to the Philomathic Society. 1st. During the night he *disinsolated* a sheet of common paper, by exposing it to the vapor of water for an hour. 2d. He then divided the paper into two parts; one was laid aside for comparison, the other was rolled up and placed in a glass tube, to one end of which ozonized oxygen was supplied; at the end of a quarter of an hour the ozone was distinctly perceived at the other extremity; the paper was then withdrawn. 3d. This paper, used in the same manner as M. Niepce's insolated paper, produced the same effects; the paper kept for comparison produced none of them. 4th. A paper treated with chlorine or nitrate of silver, and then ozonized, gave, on the contrary, no sensible result. 5th. Common paper, ozonized and kept for some time in a test tube, disengages a smell which is not that of ozone, but that of a very diffusible essence. What shall we conclude from this? added M. Thenard,— That the phenomena of insolation described by M. Niepce are chemical phenomena, determined indirectly by the light, which acts in this matter only as an intermediate agent.

The subject has also been investigated by M. Laborde, who is led by his experiments to conclude that the active agent "is an emanation, not a radiation."

The following are two of his experiments:

1st. The sensitive paper was partly covered by glass plate, in contact with it; another plate, of glass or ivory, was placed across the first, so as to oppose the direct radiation from the part which covered it, but not to the circulation of any vapors emanated; when the box was opened, the paper was found evenly blackened throughout, except under the glass in contact with the paper.

2d. The box containing the insolated sheet was left for four hours in a warm place. M. Laborde then opened it carefully, and, holding the opening downwards, gently withdrew the sheet; then, quickly fixing the sensitive paper upon the cork, he re-closed the box and placed it in a cool place. When it was again opened, after twelve hours, the sensitive paper was found blackened, notwithstanding the absence of the insolated sheet.

SOLAR LIGHT AND HEAT.

M. de Chacornac, after numerous observations, has arrived at the conclusion that the central portion of the solar disc, equal to three-tenths of its diameter, is the most brilliant; and that the luminosity gradually diminishes from the edge of this space to the rim of the disc. Near its edge the light is only half as brilliant as in the central space.

M. Secchi has also made analogous discoveries with respect to the sun's heat, and finds that the calorific power of the zone nearest the edge of the disc is only half that of the centre.

ON THE MEASUREMENT OF THE CHEMICAL ACTION OF THE SOLAR RAYS.

In a recent lecture on the above subject before the Royal Institution, London, Professor Roscoe stated: That the heating rays of the solar spectrum vibrate most slowly, and are situated near the red end; while at the violet end are found the most rapidly vibrating or chemical rays, by whose agency

plants decompose the carbonic acid of the air, assimilate the carbon, and give off the oxygen for the use of the animal creation. The intensity of the chemical rays is measured by an instrument which contains equal volumes of chlorine and hydrogen, and enables the quantity of hydro-chloric acid formed by their combination to be accurately ascertained. The mixed gases do not combine in the dark, and the quantity of acid formed is directly proportional to the incident light. In order to institute a comparison, it is necessary to agree upon a unit or standard flame. This is obtained by a jet of ignited carbonic oxide gas of known dimensions. The unit amount of chemical action is that effected by such a flame acting for one minute, at a distance of one meter, upon the mixed gases. Ten thousand such units are called one chemical degree of light. In measuring the sun's action, the chemical photometer must not be exposed to the full blaze of its beams, or the effect would be too violent. A known portion of solar rays are therefore admitted through a small aperture, and by means of Silbermann's heliostate the solar image is reflected all day upon the same spot. When the effect of a given portion of the light is known, the effect of the whole can be calculated. A cloudless day should be selected for these observations. In one experiment, made on the 15th of September, 1858, the total action of the sun, at 7h. 9m., A.M., was 5.54 degrees; and by 9h. 14m. it reached 67.61 degrees. The larger action, as the sun rises higher, is occasioned by the diminution of the column of air through which its rays pass, and a consequent lessening of their absorption. Knowing the law according to which this effect takes place, the action of solar rays upon different parts of the globe, or upon different planets, can be calculated. Thus Mercury experiences an action equal to 2125.0 degrees, while Neptune enjoys only 0.4. The differences upon the earth are very striking. Thus, at noon, at the vernal equinox, Melville Island has 3.51 degrees solar chemical action; Manchester, 47.15, and Cairo, 105.3. Chemical action of this kind is greater at elevations than on the sea-level. In the highlands of Thibet, where wheat flourishes at 12,000 and 14,000 feet above the sea, the sun's chemical action is one and a half times as great as in the adjacent lowlands of Hindostan. It is to be regretted that at present there is no easy and portable instrument for making these observations.

PHOTOGRAPHING COLOR.

A short paper, by Sir John Herschel, in the London *Photographic News*, contains some important remarks on this subject. Sir John expresses his firm belief that the problem will one day be solved; and mentions a photograph in his own possession, in which green foliage is unmistakably distinguished as green from the sepia tints of other portions of the picture. He considers it important, in attempts to obtain color, that the non-luminous rays should be cut off, which can be done by quinine. In the absence of a perfect positive photography, he reminds experimenters that they must work through the intervention of a negative; and that they ought not to expect this negative to be colored, either as the objects are, or with their complementary colors, in order to yield a colored picture by the process of photographic painting. The effect of colors in the object would thus be to convert the negative into absorbent media, which would reproduce the colors from whose action they were derived.

SUN SIGNALS FOR THE USE OF TRAVELLERS.

If a piece of looking-glass be held in such a position that a person at a distance can see some portion or other of the sun's disc reflected in it, it assumes the appearance of an exceedingly brilliant star of solar light. At a recent meeting of the Royal Geographical Society, Mr. Francis Galton, the African traveller, described an optical arrangement he had devised, by which the signaller may know whether he is holding the mirror aright. The smallest size of hand heliostat can literally be carried in the waistcoat pocket, yet, by its means, whenever the sun is shining, a signal can be instantly made that shall be visible to the entire neighborhood of any given spot within sight. A distance of twelve miles, on a day of average clearness, is well within the power of this little instrument. If the flash be replied to, a regular communication can be carried on, in which the signals are varied by gentle movements of the hand that cause the flash to be seen and to disappear alternately; words and sentences are communicated by a notation of long and short flashes, identical with the notation of long and short beats that is used in Morse's electric telegraph.

ON THE SEPARATION OF THE HEAT AND LIGHT OF THE SUN'S RAYS IN THE EYE.

A paper has recently been communicated to the French *Academie des Sciences*, by J. M. Janssen, giving an account of a series of experiments undertaken by him to ascertain how large a portion of the *heat*-rays pass through the central portions of the eye and reach the retina at the back. His experiments show that *all* the rays of heat are absorbed before they reach the retina,—two-thirds by the cornea, and the other third by the aqueous humor.

THE MECHANICAL THEORY OF HEAT.

The following paper, communicated by Mr. D. V. Clark, C. E., to the London *Engineer*, sets forth in a popular manner what is now understood by the so-called "mechanical theory of heat." The principle of this theory of heat is, that, independently of the medium through which heat may be developed into mechanical action, the same quantity of heat converted is invariably resolved in the same total quantity of mechanical action. For the exact expression of this relation, of course, units of measure are established, in terms of the English foot, as the measure of space; the pound avoirdupois, as the measure of weight, pressure, elasticity; and the degree of Fahrenheit's scale, as the measure of temperature and heat. Work done consists of the exertion of pressure through space, and the English unit of work is the exertion of one pound of pressure through one foot, or the raising of one pound weight through a vertical height of one foot,—briefly, a foot-pound. The unit of heat is that which raises the temperature of one pound of ordinary cold water by one degree Fahrenheit. If two pounds of water be raised one degree, or one pound be raised two degrees in temperature, the expenditure of heat is, equally in both cases, two units of heat. Similarly, if one pound weight be raised through one foot, or two pounds weight be raised through two feet, the power expended, or work done, is equally in both cases two units of work, or two foot-pounds. From these definitions, then, the comparison lies between the unit of heat, on the one

part, and the unit of work, or the foot-pound, on the other. M. Clapeyron, in his treatise on the moving power of heat, and M. Noltzman, of Manheim, in 1845, who availed himself of the labors of M. Clapeyron and M. Carnot in the same field, grounding their investigations on the received laws of Boyle or Marriotte, and Gay-Lussac, which express the observed relations of heat, elasticity, and volume in steam and other gaseous matter, concluded that the unit of heat was capable of raising a weight, between the limits of six hundred and twenty-six pounds and seven hundred and eighty-two pounds, one foot high; that is to say, that one unit of heat was equivalent to from six hundred and twenty-six to seven hundred and eighty-two foot-pounds. By this mode of investigation, they suppose a given weight of steam or gaseous matter to be contained in a vertical cylinder formed of non-conducting material, in which is fitted an air-tight but freely moving piston, which is pressed downward by a weight equal to the elasticity of the gas. Now, the weight, initial temperature, pressure, and volume, being known, a definite quantity of heat from without is supposed to be imparted to the vapor; and the result is partly an elevation of the temperature of the vapor, and partly a dilation or increase of volume; or, in other words, an exertion of pressure through space, the elasticity remaining the same. But the result may be represented entirely by dilation, so that there shall not be any final alteration of temperature; and for this purpose it is only necessary to allow the vapor to dilate without any loss of its original or imparted heat until it reacquires its initial temperature. In this case, the ultimate effect is purely dilatation, or motion against pressure; and the work done is represented by the product of that pressure into the space moved through.

Mr. Joule, of Manchester, in 1843–47, proceeded, by entirely different, independent, and, in fact, purely experimental methods, to investigate the relation of heat and work. 1st. By observing the calorific effects of magneto-electricity. He caused to revolve a small compound electro-magnet immersed in a glass vessel containing water between the poles of a powerful magnet; heat was proved to be excited by the machine by the change of temperature in the water surrounding it, and its mechanical effect was measured by the motion of such weights as by their descent were sufficient to keep the machine in motion at any assigned velocity. 2d. By observing the changes of temperature produced by the rarefaction and condensation of air. In this case, the mechanical force producing compression being known, the heat excited was measured by observing the changes of temperature of the water in which the condensing apparatus was immersed. 3d. By observing the heat evolved by the friction of fluids. A brass paddle-wheel, in a copper can containing the fluid, was made to revolve by descending weights. Sperm oil and water yielded the same results. Mr. Joule considered the third method the most likely to afford accurate results; and he arrived at the conclusion that one unit of heat was capable of raising seven hundred and seventy-two pounds one foot in height; or that the mechanical equivalent of heat was expressible by seven hundred and seventy-two foot-pounds for one unit of heat — known as "Joule's equivalent."

The following are the values of Joule's equivalent for different thermometric scales, and in English and French units: —

1 English thermal unit, or 1 deg. Fah. in 1 lb. of water,	772 foot-pounds.
1 centigrade degree in 1 lb. of water, ...	1389.6 "
1 French thermal unit, or 1 centigrade degree in a kilogramme of water, ...	423.55 kilogrammetres.

The mechanical theory of heat rests upon a wide basis, and proofs in verification of the theory are constantly accumulating. When the weight of any liquid whatever is known, with the comparative weight of its vapor at different pressures, the latent heat at the different pressures is readily estimated from the theory; and this method of estimation agrees with the best experimental results, as may afterwards be shown; and when the latent heat is also known, the specific heat of the liquid can be determined by means of the same theory; in other words, the quantity of work, in foot-pounds, may be determined, which would, by agitating the liquid or by friction, be required to raise the temperature of any given quantity of the liquid by, say, one degree, altogether independently of Joule's experiments. The theory enables us to discover the utmost power it is possible to realize from the combination of any given weight of carbon and oxgyen, or other elementary substances, with nearly as much precision as we can estimate the utmost quantity of work it is possible to obtain from a known weight of water falling through a given height. It is not difficult to comprehend, then, that the theory of the mechanical equivalent of heat proves of great practical utility.

According to the mechanical theory of heat, in its general form, heat, mechanical force, electricity, chemical affinity, light, sound, are but different manifestations of motion. Dulong and Gay-Lussac proved by their experiments on sound that the greater the specific heat of a gas, the more rapid are its atomic vibrations. Elevation of temperature does not alter the rapidity, but increases the length of the vibrations, and, in consequence, produces "expansion" of the body. All gases and vapors are assumed to consist of numerous small atoms, moving or vibrating in all directions with great rapidity; but the average velocity of these vibrations can be estimated when the pressure and weight of any given volume of gas is known, pressure being, as explained by Joule, the impact of those numerous small atoms, striking in all directions, and against the sides of the vessel containing the gas. The greater the number of these atoms, or the greater their aggregate weight, in a given space, and the higher the velocity, the greater is the pressure. A double weight of a perfect gas, when confined in the same space, and vibrating with the same velocity,—that is, having the same temperature,—gives a double pressure; but the same weight of gas, confined in the same space, will, when the atoms vibrate with a double velocity, give a quadruple pressure. An increase or decrease of temperature is simply an increase or decrease of molecular motion. The truth of this hypothesis is very well established, as already intimated, by the numerous experimental facts with which it is in harmony.

When a gas is confined in a cylinder under a piston, so long as no motion is given to the piston, the atoms, in striking, will rebound from the piston after impact with the same velocity with which they approached it, and no motion will be lost by the atoms. But when the piston yields to the pressure, the atoms will not rebound from it with the same velocity with which they strike, but will return after each succeeding blow with a velocity continually decreasing as the piston continues to recede, and the length of the vibrations will be diminished. The motion gained by the piston will, it is obvious, be precisely equivalent to the energy, heat, or molecular motion, lost by the atoms of gas. Vibratory motion, or heat, being converted into its equivalent of onward motion, or dynamical effect, the conversion of heat into power, or of power into heat, is thus simply a transference of motion; and it would be as reasonable to expect one billiard-ball to strike and give motion to an-

other without losing any of its own motion, as to suppose that the piston of a steam-engine can be set in motion without a corresponding quantity of energy being lost by some other body.

In expanding air spontaneously to a double volume, delivering it, say, into a vacuous space, it has been proved repeatedly that the air does not fall appreciably in temperature, no external work being performed; but, on the contrary, if the air, at a temperature, say, of two hundred and thirty degrees Fahrenheit, be expanded under pressure or resistance, as against the piston of a cylinder, giving motion to it, raising a weight, or otherwise doing work by giving motion to some other body, the temperature will fall nearly one hundred and seventy degrees when the volume is doubled, that is, from two hundred and thirty degrees to about sixty degrees; and, taking the initial pressure of forty pounds, the final pressure would be fifteen pounds per square inch.

When a pound weight of air in expanding, at any temperature or pressure, raises one hundred and thirty pounds one foot high, it loses one degree in temperature; in other words, this pound of air would lose as much molecular energy as would equal the energy acquired by a weight of one pound falling through a height of one hundred and thirty feet. It must, however, be remarked, that but a small portion of this work, one hundred and thirty foot-pounds, can be had as available work, as the heat which disappears does not depend on the amount of work or duty realized, but upon the total of the opposing forces, including all resistance from any external source whatever. When air is compressed the atmosphere descends and follows the piston, assisting in the operation with its whole weight; and when air is expanded, the motion of the piston is, on the contrary, opposed by the whole weight of the atmosphere, which is again elevated. Although, therefore, in expanding air the heat which disappears is in proportion to the total opposing force, it is much in excess of what can be rendered available; and, commonly, where air is compressed, the heat generated is much greater than that which is due to the work which is required to be expended, the weight of the atmosphere assisting in the operation.

Let a pound of water, at a temperature of two hundred and twelve degrees Fahrenheit, be injected into a vacuous space or vessel, having 26.36 cubic feet of capacity, — the volume of one pound of saturated steam at that temperature, — and let it be evaporated into such steam, then 893.8 units of heat would be expended in the process. But if a second pound of water, at two hundred and twelve degrees, be injected and evaporated at the same temperature, under a uniform pressure of 14.7 pounds per square inch due to the temperature, the second pound must dislodge the first, by repelling that pressure, involving an amount of labor equal to 55,800 foot-pounds (that is, 14.7 pounds $\times$ 144 square inches $\times$ 26.36 cubic feet), and an additional expendi- of 72.3 units of heat (that is, $55{,}800 \div 772$), making a total for the second pound of 965.1 units.

Similarly, when one thousand four hundred and eight units of heat are expended in raising the temperature of air at constant pressure, one thousand of the units increase the velocity of the molecules, or produce a sensible increment of temperature; while the remaining four hundred and eight parts, which disappear as the air expands, are directly expended in repelling the external pressure.

Again: If steam be permitted to flow from a boiler into a comparatively vacuous space, without giving motion to another body, the temperature of

the steam entering this space would rise much higher than that of the steam in the boiler. Or, suppose two vessels side by side, one of them vacuous and the other filled with air at, say, two atmospheres, a communication being opened between the vessels, the pressure would become equal in the two vessels; but the temperature would fall in one vessel and rise in the other; and although the air is expanded in this manner to a double volume, there would not on the whole be any appreciable loss of heat; for, if the separate portions of air be mixed together, the resulting average temperature of the whole would be very nearly the same as at first. It has been proved experimentally, corroborative of this argument, that the quantity of heat required to raise the temperature of a given weight of air to a given extent, was the same, irrespective of the density or volume of the air. Regnault and Joule found that to raise the temperature of a pound weight of air one cubic foot in volume, or ten cubic feet, the same quantity of heat was expended.

In rising against the force of gravity steam becomes colder, and partially condenses while ascending, in the effort of overcoming the resistance of gravity, by the conversion of heat into water. For instance, a column of steam weighing, on a square inch of base, 250.3 pounds, — that is, a pressure of 250.3 pounds per square inch, — would, at a height of 275,000 feet, be reduced to a pressure of one pound per square inch; and ascending to this height, the temperature would fall from four hundred and one degrees to one hundred and two degrees Fahrenheit; while, at the same time, nearly twenty-five per cent of the whole vapor would be precipitated in the form of water, if not supplied with heat while ascending.

If a body of compressed air be allowed to rush freely into the atmosphere, the temperature falls in the rapid part of the current by the conversion of heat into motion; but the heat is almost all reproduced when the motion is quite subsided; and from recent experiments it appears that nearly similar results are obtained from the emission of steam under pressure.

When water falls through a gaseous atmosphere its motion is constantly retarded as it is brought into collision with the particles of that atmosphere, and by this collision it is partly heated and partly converted into vapor.

If a body of water descends freely through a height of seven hundred and seventy-two feet, it acquires from gravity a velocity of two hundred and twenty-three feet per second; and if suddenly brought to rest when moving with this velocity, it would be violently agitated, and raised one degree in temperature. But suppose a water-wheel, seven hundred and seventy-two feet in diameter, into the buckets of which water is quietly dropped, when the water descends to the foot of the fall, and is delivered gently into the tail-race, it is not sensibly heated. The greatest amount of work it is possible to obtain from water falling from one level to another lower level is expressible by the weight of water multiplied by the height of the fall.

The object of these illustrative exhibitions of the nature and reciprocal action of heat and motive power, with their relations, are: first, to familiarize the reader with the doctrine of the mechanical equivalence of heat; second, to show that the nature and extent of the change of temperature of a gas, while expanding, depends nearly altogether upon the circumstances under which the change of volume takes place.

NEW METALLIC THERMOMETERS.

A new registering thermometer invented by Dr. James Lewis, of Mohawk, N. Y., has the following construction:—

The part of the instrument forming the thermometer proper consists of a cylindrical bundle of iron and brass wires (No. 13), about fifteen inches in length, so arranged as to be equivalent to about forty-five inches of iron wire antagonized by about an equal length of brass wire. The bundle is composed of five pairs, two of brass and three of iron, arranged alternately around the centre, and a single wire of brass, equivalent in action to a third pair of that metal, placed in the axis of the cylinder. The upper end of the central wire, moved by the difference of expansion of the two metals, operates upon the short arm of the first of a train of two levers, and through them upon the axle of a pulley. To the grooved circumference of the larger wheel of this pulley is attached a slender silk cord, carrying the registering point designed to mark the temperature, and which, by the multiplying effect of the mechanism, is moved over a space three hundred and twenty times as great as the differential expansion or contraction of the wires. The registering point, properly balanced by an attached weight, and guided in its vertical movements by two slender parallel rods, is made to record the temperature on a fillet of paper moved by a train of cylinders whose axes are parallel to the guide-wires. The record is impressed by the impulse of a hammer striking upon the back of the registering point at regulated intervals, and thus producing a series of small perforations in the paper, the hammer and the fillet of paper both receiving their motion from a train of clock-work, of peculiar construction, connected with the apparatus.

The projecting shaft of the pulley carries an index, which, revolving in front of a dial-plate placed over the pulley, enables the observer to note the temperature as compared with the ordinary thermometer, and to adjust the rod-thermometer to the standard whenever necessary. The adjustment is made by turning a screw connected with the lower end of the central brass wire of the thermometer. The latter instrument is on the outside of the case which incloses the dial, registering apparatus, and clock. By a peculiar arrangement of the clock-work, the hammer movements, and therefore the times of registration, may be adjusted to quarter-hour, half-hour, or hour intervals, and may be changed from one to the other at the will of the observer.

The above description is derived from a report made to the Boston Society of Natural History, by Professor W. B. Rogers, who also takes occasion to recommend the instrument as worthy the critical examination of men of science, and one which, from its great sensitiveness and accuracy, promised to become a valuable help in meteorological observations.

Beaumont's new Metallic Thermometer. — The principle of a new thermometer recently invented by Victor Beaumont, of New York, is the dilatation of different metals. A straight strip of brass and a similar strip of steel are soldered together; when heated, the compound strip expands more on the brass side than on the other, hence bends in a curve. One end of the strip is made fast to the case; the other end is connected, by means of a link and a crank, to the spindle which carries the hand. The crank is provided with a regulating screw, by means of which the range of motion is made to correspond with the graduation on the dial; and the whole machinery of the spindle is carried on a stand, which is moved by another screw, to set the instrument after a standard. This setting screw is reached from the outside, and if the thermometer gets out of order it may easily be set to work correctly by means of a screw-driver. The external appearance of the instrument is that of a watch, four inches diameter, with a Fahrenheit and a centi-

grade scale on the dial. These thermometers are correct, portable, easily read, and very quick, since the expanding metal is in direct contact with the air, which enters the cases by holes made for the purpose. Metallic thermometers, especially Breguet's, are used in laboratories to measure very minute variations of temperature, but they are very dear. Mr. Beaumont has succeeded, by means of well-adapted tools, in making them cheaper than accurate mercurial thermometers. And he adapts them to several uses, for which they are unrivalled, namely, for vacuum sugar-pans, gas-workers, measuring temperatures below the freezing point of mercury, measuring the temperature of super-heated steam and of hot-air furnaces, up to 1.200° Fahrenheit.

DEEP-SEA THERMOMETER.

The principle of a new deep-sea thermometer, devised by Mr. Wentworth Scott, of England, is as follows: The upper portion of the thermometer (glass) tube terminates in a capillary orifice, bent at a right angle to it, and enclosed in a vacuum chamber, the lower part of which contains mercury. By inverting the thermometer the mercury runs from the bulb up the stem and through the orifice, until the latter is covered and a vacuum left below. The reservoir bulb is then slightly elevated, and a portion of mercury runs back again, leaving the thermometer tube quite full to the point of the capillary orifice. In this condition it is obvious that any additional heat must cause the mercury to flow out of the orifice in small drops, which are, so to speak, helped out by a fine platinum wire, which prevents the formation of large drops. Upon cooling, the mercury sinks, and the vacant space, left by the effusion of a portion of it, is a measure of the heat to which the instrument has been exposed, and it is graduated so as to facilitate the necessary calculations.

ON THE USE OF STEAM EXPANSIVELY.

Much interest is now felt among engineers as to the economy of using steam expansively. Mr. Isherwood, chief engineer of the United States Navy, after a long series of experiments in the Brooklyn Navy-yard, came to the conclusion that there was no appreciable advantage derived from working it expansively. Recent experiments at the Metropolitan Flouring Mills, in New York City, where there are two pairs of very fine engines, indicate, also, that there is no advantage in it, in spite of the very evident theoretical gain.

CAUSES OF COLD ON HIGH MOUNTAINS.

A recent number of the *Annales de Chimie et de Physique* contains an interesting paper, by M. Martins, on the above subject. He treats first of the action of solar rays, and the absorption of their heat by the atmosphere in proportions varying with its density. In consequence of the greater rarefaction of air on mountains it stops less of the solar heat, and hence, in clear weather, the sun's rays exert a greater heating power upon the earth than they do at a lower level. Repeating, with better instruments, some experiments of Saussure, he came to the same conclusion; and asserts that the solar heating power is greater on a mountain than in the valley, although the temperature of the air was twenty-two degrees lower. The difference was, however, only slight, amounting only to a fraction of a degree (centigrade).

He remarks that if this difference appears small to some readers, they will, at least, admit that the solar rays have equal power on mountain-tops as in the valleys beneath. The results of a series of observations on the temperature of the soil on mountains lead to the conclusion that its mean temperature was greater than that of the air; while at Brussels, and other low situations, the mean temperature of the air was a little higher than that of the earth. He found that this warming of the earth on mountains was not confined to the summer, but that between the twenty-first of September and the first of October it was even greater. This relative heating of the earth on mountains exercises an important influence on Alpine vegetation, and likewise drives the permanent snow-line to a higher region. But although the soil of mountains is warmed, as well as that of the plains, the air is much colder, and the nocturnal radiation much greater, so much so as to constitute a proof that the earth must receive more warmth during the day, or its temperature would fall lower than is observed. M. Martins remarks, that on a plain the earth is only in contact with the lower stratum of the atmosphere, while an isolated peak, like the Faulhorn, is plunged into the aerial sea, and radiates, not only towards the zenith, but in every direction, and the process is favored by the rarefaction of the air. When mountains are covered with snow their radiation is still more considerable, especially at altitudes at which it never melts, and where it remains as a fine powder or dust. Flocculent snow does not exhibit this great radiating power. Another cause of the cooling of the earth and air on mountains is the great evaporation which takes place, and which, other things being equal, is more active than in the plains. Another cause is the dilatation of ascending currents, owing to the diminution of atmospheric pressure; a subject upon which M. Martins made numerous experiments, of which he tabulates the results, and in which he imitated, as far as possible, natural conditions. Passing from the question of thermometrical cold, M. Martins considers the reasons of the sensation of cold experienced by travellers. Among these he reckons the agitation of the air, which, he says, is never quiet on isolated peaks. He likewise notices the effect of walking through the intensely cold, deep, powdery snow, and the deficient supply of oxygen, through breathing rarefied air.

ON THE EXISTENCE OF A LUNAR TIDAL-WAVE ON THE GREAT AMERICAN LAKES.

The following letter has been addressed to the Editor of the Annual of Scientific Discovery, by Lieutenant Colonel J. D. Graham, of the Topographical Engineers, U. S. A., Superintendent of Lake and Harbor Improvements for the Northern Lakes.

Until the announcement to the Topographical Bureau of the War Department, contained in my annual report of November 15, 1858,[1] and to the Chicago Historical Society at its annual meeting on the 30th of that month,[2] the existence of a lunar tidal-wave on our great North American fresh-water lakes had never been demonstrated; but, on the contrary, it had very generally been denied. That announcement was based upon a series of daily

1 See pp. 1107 and 1108 of vol. ii. Part 2 of Congressional (Executive) Doc., No. 2, of the 35th Congress, 2d Session.

2 See Historical Magazine, vol. iii., p. 89, published monthly, at New York, by C. B. Richardson.

observations very carefully made upon a tide-gauge established at the outer or lakeward extremity of the north harbor-pier, off the entrance to Chicago harbor, during the four consecutive years previous. During the last four months preceding the announcement, the observations were made upon the tide-gauge at least twice a day, namely, when the moon was south, or on the meridian, and when in the horizon, or at or very near the periods which corresponded to the time of lunar high and low water. From at least a day before to a day after the full of the moon, the observations were made either hourly or half-hourly. These were the data for the first announcement.

For the more complete solution of this problem we afterwards instituted a special series of observations, intended to show not only the elevation of this tidal-wave at its summit, but also its elevation at every half hour or quarter hour of its progress from low to high water, and thence to low water again. This series was commenced on the 1st of January, and continued, both day and night, at every half hour ordinarily, and at every quarter hour from one day before to at least two days after the periods of the new and full moon, up to the 1st of July of the year 1859, a continuous period of six months.

It embraced nine thousand one hundred and eighty-four observations of the tide-gauge.

As many as two hundred and thirty-two observations were lost during several periods of violent storms, chiefly in February and March, 1859. But for this loss, our series would have embraced nine thousand four hundred and sixteen observations.[1]

We assumed the times of the moon's meridian passage, whether culminating or antipodal, as periods of comparison, and reduced all the nine thousand one hundred and eighty-four observations to the nearest half-hour or quarter-hour period of elapsed time for each lunar half day. In this way we obtained the half-hour coördinates of elevation of the surface of Lake Michigan, at Chicago, from lunar low to lunar high water, and thence again to lunar low water, for our demonstration of the average semi-diurnal lunar tide for the whole period of six months. In a similar way the quarter-hour coördinates were obtained for the demonstration of the character of the average semi-diurnal spring-tide during five conjunctions and five oppositions of the moon and sun.

The results of this investigation were communicated in a paper to the American Association for the Advancement of Science, at its fourteenth meeting, which took place at Newport, Rhode Island, on the 1st of August, 1860.

The following Table (I.) shows the average semi-diurnal lunar tide on Lake Michigan, derived from the above-mentioned nine thousand one hundred and eighty-four observations, embracing every vicissitude, whether favorable or unfavorable, of winds, weather, etc., which attended them.

Here we have one hundred and forty-six thousandths of a foot, or one and three-fourths inch, as the general average height of the summit of the semi-

[1] The general result from the first half of this series, verifying our first announcement, was communicated to the Topographical Bureau in my annual report of October 31, 1859. The memoir embracing the subject will be found printed at pp. 895 to 898, and at pp. 929 to 938 of vol. iii. of Senate Executive Doc., No. 2, of the 36th Congress, 1st Session.

diurnal lunar tidal-wave on Lake Michigan, at Chicago; and thirty minutes after the period of the moon's meridian passage as the average time of lunar high water. These are the results from *all* the observations made during the six months' series.

TABLE I. — *Showing the half-hourly (and at two periods the quarter-hourly) coördinates of altitude of the average semi-diurnal lunar tidal-wave at Chicago, on Lake Michigan, derived from the whole* 9,184 *observations made.*

Mean Solar intervals of time before the Moon's meridian passage.	Observed elevation of the lake surface, in decimals of a foot.	Mean Solar intervals of time after the Moon's meridian passage.	Observed elevation of the lake surface, in decimals of a foot.
h. m.	Foot Decimals.	h. m.	Foot Decimals.
5 35	0.000[1]	0 30	0.146[3]
5 30	0.004	0 45	0.143
5 00	0.008	1 00	0.134
4 30	0.016	1 15	0.134
4 00	0.030	1 30	0.130
3 30	0.040	2 00	0.116
3 00	0.053	2 30	0.112
2 30	0.078	3 00	0.082
2 00	0.087	3 30	0.066
1 30	0.089	4 00	0.048
1 00	0.115	4 30	0.040
0 30	0.130	5 00	0.032
0 00[2]	0.140[2]	5 30	0.024
		6 00	0.030[4]
		6 30	0.012
		6 50	0.000[1]

TABLE II. — *Showing the half-hourly (and at two periods the quarter-hourly) coördinates of altitude of the average semi-diurnal lunar tidal-wave at Chicago, on Lake Michigan, as derived from* 8,995 *out of the* 9,184 *observations made between January* 1st *and July* 1st, 1859.

Mean Solar intervals of time before the Moon's meridian passage.	Observed elevation of the lake surface, in decimals of a foot.	Mean Solar intervals of time after the Moon's meridian passage.	Observed elevation of the lake surface, in decimals of a foot.
h. m.	Foot Decimals.	h. m.	Foot Decimals.
5 33	0.000[1]	0 30	0.153[3]
5 30	0.005	0 45	0.148
5 00	0.004	1 00	0.137
4 30	0.013	1 15	0.134
4 00	0.030	1 30	0.132
3 30	0.041	2 00	0.113
3 00	0.054	2 30	0.107
2 30	0.078	3 00	0.084
2 00	0.090	3 30	0.056
1 30	0.098	4 00	0.040
1 00	0.108	4 30	0.031
0 30	0.127	5 00	0.025
0 00[2]	0.148[2]	5 30	0.023
		6 00	0.024
		6 30	0.010
		6 50	0.000[1]

1 Lunar low-water. 2 Moon on Meridian. 3 Lunar high-water.

4 Slightly discrepant, owing to a preponderance of unfavorable winds at this particular period.

On a close examination of all the observations embraced in this series, we find one hundred and eighty-nine which we think ought to be rejected, because influenced in an extraordinary degree by unfavorable winds, and we think the average semi-diurnal lunar tidal-curve should rather be adopted, as shown by the remaining eight thousand nine hundred and ninety-five observations.

The general result will then stand as shown in the preceding Table (II.), page 169.

Under this view we have one hundred and fifty-three thousandths of a foot, or $1\frac{84}{100}$ inch, as the general average height of this semi-diurnal tidal-wave at its summit; and thirty minutes after the moon's meridian passage still appears to be the average time of lunar high-water.

A separate tabulation was made, for every quarter-hour of interval, of all the observations which occurred from twelve hours before to twenty-four hours after the periods of new and full moon, for each lunation. In this way we hoped to obtain, at each new and at each full moon, six semi-diurnal tides, each of which would approximately represent a semi-diurnal spring-tide, and a mean of all would tend to eliminate errors arising from the disturbing

TABLE III. — *Showing the quarter-hourly coördinates of altitude of the average semi-diurnal lunar spring tidal-wave at Chicago, on Lake Michigan, as derived from* 1200 *observations made at and near the several periods of New and Full Moon, between January* 3*d and June* 2*d,* 1859.

Mean Solar interval of time before the Moon's meridian passage.	Observed elevation of the lake surface, in decimals of a foot.	Mean Solar interval of time after the Moon's meridian passage.	Observed elevation of the lake surface, in decimals of a foot.
h. m.	Foot Decimals.	h. m.	Foot Decimals.
6 00	0.000[1]	0 15	0.248
5 45	0.006	0 30	0.254[3]
5 30	0.014	0 45	0.241
5 15	0.029	1 00	0.229
5 00	0.035	1 15	0.226
4 45	0.042	1 30	0.221
4 30	0.049	1 45	0.221
4 15	0.057	2 00	0.201
4 00	0.079	2 15	0.179
3 45	0.081	2 30	0.161
3 30	0.089	2 45	0.140
3 15	0.091	3 00	0.120
3 00	0.101	3 15	0.112
2 45	0.121	3 30	0.103
2 30	0.129	3 45	0.093
2 15	0.145	4 00	0.072[4]
2 00	0.153	4 15	0.066
1 45	0.169	4 30	0.072
1 30	0.178	4 45	0.067
1 15	0.187	5 00	0.059
1 00	0.195	5 15	0.046
0 45	0.216	5 30	0.040
0 30	0.225	5 45	0.042[4]
0 15	0.226	6 00	0.050[4]
0 00[2]	0.233[2]	6 15	0.027
		6 28	0.000[1]

1 Low-water of lunar spring-tide. 2 Moon on Meridian.
3 High-water of lunar spring-tide.
4 Slightly discrepant, owing to a preponderance of unfavorable winds at this particular period.

forces caused by the irregularity both of the directions and strength of the winds. The losses already mentioned, occasioned by violent storms, extended in part to these spring-tides. We were fortunate enough, however, to obtain good quarter-hourly observations for as many as twenty-four of these semi-diurnal spring-tides. The mean result from them is shown in the preceding Table (III.), page 170.

Here we have, again, thirty minutes after the time of the moon's meridian passage as the time of high water at the period of lunar spring-tides; and we have two hundred and fifty-four thousandths of a foot, equal to 3.408 inches, United States measure, as the height of the lunar spring-tidal wave at its summit.

In accordance with custom, in like cases, we indicate as the established mean for the port of Chicago,

¼ Foot, 0h. 30m.

Although this indication may be but of small practical advantage to navigators, yet it may serve as a memorandum of a physical phenomenon whose existence has very generally, heretofore, been either denied or doubted.

We think it probable that if the effects of unfavorable winds, and all other extraneous forces which produce irregular oscillations in the elevation of the lake surface, could be fully eliminated, a semi-diurnal lunar spring-tide would be shown as great as one-third of a foot, or four inches, for the periods of highest tides.

The time of low water, and the relative times of duration of the flood and ebb tides, are given only approximately. The extreme rise of the tide being so little, the precise time of the change from ebb to flood, and hence the duration of the flow of each, can only be accurately determined by numerous observations at short intervals of time, say three to five minutes apart, from about an hour before to an hour after the turn of the tide from ebb to flood.

In conclusion, we offer the foregoing observations as solving the problem in question, and as proving the existence of a semi-diurnal lunar tidal-wave on Lake Michigan, and consequently on the other great fresh-water lakes of North America, whose coördinate of altitude at its summit is as much as .15 to .254 of a foot, or from 1.8 to 3.048 inches, U. S. measure.

ON THE PHENOMENON OF WAVES ON THE SURFACE OF MERCURY.

Nothing can be more interesting than the rippling of water under certain circumstances. By the action of interference its surface is sometimes shivered into the most beautiful mosaic, shifting and trembling as if with a kind of visible music. When the tide advances over a sea-beach on a calm and sunny day, and its tiny ripples enter at various points the clear, shallow pools which the preceding tide had left behind, the little wavelets run and climb and cross each other, and thus form a lovely chasing, which has its counterpart in the lines of light converged by the ripples upon the sand underneath. When waves are skilfully generated in a vessel of mercury, and a strong light reflected from the surface of the metal is received upon a screen, the most beautiful effects may be observed. The shape of the vessel determines, in part, the character of the figures produced; in a circular dish of mercury, for example, a disturbance at the centre propagates itself in

circular waves, which, after reflection, again encircle the centre. If the point of disturbance be a little removed from the centre, the intersections of the direct and reflected waves produce magnificent chasing. The luminous figure reflected from such a surface is exceedingly beautiful. When the mercury is lightly struck by a glass point, in a direction concentric with the circumference of the vessel, the lines of light run round the vessel in mazy coils, interlacing and unravelling themselves in the most wonderful manner. If the vessel be square, a splendid mosaic is produced by the crossing of the direct and reflected waves. Description, however, can give but a feeble idea of these exquisite effects. — *Professor Tyndall.*

ON THE DESTRUCTIVE EFFECTS OF WAVES.

Mr. Thomas Stevenson, C. E., in a communication to the Royal Society of Edinburgh, states that he had found on one of the Shetland Islands, exposed to the waves of the North Sea, or German Ocean, masses of rock weighing nine and a half tons and under, heaped together by the action of the waves, at the level of no less than sixty-two feet above the sea; and others, ranging from six to thirteen tons, were found to have been quarried out of their positions *in situ*, at levels of from seventy to seventy-four feet above the sea; another block, of seven and one-sixteenth tons, at the level of twenty feet above the sea, had been quarried out and transported to a distance of seventy-three feet, from S.S.E. to N.N.W., over opposing abrupt faces as much as seven feet in height.

Mr. S. further stated that, as the result of observation, he was of the opinion that the presence of *mud* on the sea bottom, at any depth, might be taken as a certain proof that the agitation originating at the surface had ceased to be appreciable. If the geological formation did not produce a clayey deposit, or if strong submarine currents existed, the *absence* of mud might afford no proof of the magnitude of the waves; but its *presence* in shoal water may be relied on as indicating with certainty that, in whatever locality it is found, there must be small disturbance at the surface, or, in other words, that there cannot be a heavy sea.

SEEING THE EARTH'S ANNUAL MOTION.

The pendulum experiment of Mr. Foucault, by which the diurnal motion of the earth was made visible, has been followed by a contrivance of M. Fitzeau, to exhibit the annual motion, which cannot, however, be of so popular a character; nor does it admit of simple explanation. By directing a telescope east and west at the time of the solstices, and viewing the rotation of the plane of polarization of a ray of light by means of a special apparatus which it contained, he observed a small movement, only to be accounted for by the annual motion of the earth.

Seeing the Earth's Diurnal Motion. — M. Perrot, of Paris, exhibits the diurnal motion of the earth by means of a bucket, with a small hole exactly in the centre of its bottom. The bucket is filled with water and some light powder strewn upon its surface, which shows the direction of the current produced by the escape of the water through the orifice described. This current is seen to follow a curve considerably to the right of the straight line it would take if the earth were standing still, and which is accounted for by its rotation. The action of the earth's rotation, he thinks, is also

traceable in the course of rivers, and their frequent pressure upon their right banks.

ON THE POSSIBILITY OF STUDYING THE EARTH'S INTERNAL STRUCTURE FROM PHENOMENA OBSERVED AT ITS SURFACE.

Professor Hennessy, in a paper on the above subject, read before the British Association, 1860, considered the possibility of obtaining results from the comparison of the level surface, usually called the earth's surface by astronomers and mathematicians, with the geological surface which would be presented if the earth were stripped of its fluid coating. At present the number of unknown quantities in an inquiry as to the earth's internal structure was greater than the number of conditions; but, by knowing the true surface, and adopting the results of established physical and hydrostatical laws relative to the supposed internal fluid mass, we should be able to establish as many equations as we have unknown quantities, and thus obtain a solution.

Professor Stevely stated, that the exact spheroidal form of the earth, and the direction of gravity at each part of its surface, were not so completely determined as the remarks of Professor Hennessy would lead a person to suppose. Very interesting papers, printed in the last volume of the *Transactions* of the Royal Society, by Colonel Sir Henry James and Captain Clarke, had shown conclusively that not only did the spheroidal form of the earth, as deduced from the great Ordnance Survey of the British Islands, differ somewhat from that considered as most suitable to the form of the earth, as derived from a comparison of all observations; but even particular localities had the plumb-line so affected by local circumstances that the forms, as deduced from particular portions of the survey, differed sensibly from one another. Thus, the plumb-line near Edinburgh was found to be affected not only by the proximity to Arthur's Seat and the Calton Hill, but even the defect of matter in the Frith of Forth, and the excess in the distant Portland Hills, were shown to exercise important influences.

Colonel Sir H. James showed, by various examples, that the method of grouping the measurements of different countries, proposed by Mr. Hennessy, would not, in the present state of these measurements, lead to the exact results he supposed. He then pointed out circumstances not only respecting the Russian measurements, but even the French, which would make a reëxamination of them not only desirable but necessary.

NEW METHODS OF DETERMINING SPECIFIC GRAVITY.

Until a few years ago the determination of the specific gravity of solids was conducted on one of these two principles: either by finding the loss of weight a body suffered on being immersed in water (its absolute weight being known), with the aid of the hydrostatic balance or Nicholson's areometer, or by determining, by means of a balance, the quantity of liquid displaced by the substance in question; the vessel used being a little flask holding a certain weight of water (one thousand grains).

Since the general introduction of the volumetric assay, and with it of graduated cylinders, the thought lay very near, in determining the specific gravity of dry substances, to measure instead of weighing the quantity of liquid displaced. F. Mohr has demonstrated that by far the simplest plan is

to measure the volume of water displaced; and his method is applicable to any other liquid, as alcohol, benzine, etc., since it is only with volumes, and not weights, that the calculations are made.

Three different modifications of this principle are in use, of which we give the outline. One is to fill a test-tube, which forms a straight cylinder, and is graduated, with a liquid in which the substance to be examined is insoluble, to note the height of the liquid, and to weigh the whole. The substance, in coarse powder, is next thrown in, the height of the fluid again noted, and the whole re-weighed. The two notations and weighings give the data to determine the specific gravity.

The second mode is especially adapted for bodies which, on account of size or shape, cannot be introduced into a graduated cylinder. A strip of wood, through which is stuck a pin, blackened at the point, is laid over a beaker-glass, which is then filled with water until the surface of the latter just touches the point of the pin. After introducing the substance, the water is drawn up into a graduated pipette until reduced to the same level,—even with the point of the pin. The volume of the water measured in the pipette shows that of the substance.

The third modification is intended for technical purposes more particularly. The apparatus consists of a half-gallon glass cylinder, provided with a tubulus at the lower end, through which passes, on the outside, a bent glass tube to about half the height of the cylinder, where it is bent at two right angles, ending in a fine opening, beneath which is afterwards placed a graduated cylinder. Water is poured into the large cylinder until it commences to run from the fine opening; when this ceases, the graduated cylinder is put in its place, and the substance, previously weighed, gently introduced into the large vessel. The water rises, and the quantity corresponding to the volume displaced will run from the glass tube and be measured in the graduated cylinder. We may here notice a mode of determining the specific gravity of such substances as potatoes, which is in general use among the potato distillers of Northern Germany, to guide them in the valuation of the percentage of starch, which stands in some proportion to the specific gravity of the potato. A saturated solution of common salt is prepared, and the potatoes placed in it; they will swim on top until the density of the salt liquor is reduced by water, which is added until they are suspended in the solution, but do not sink to the bottom. The specific gravity of the diluted solution is then taken with a common areometer, and is the same as that of the potatoes.

JAPANESE SCIENCE.

A recent correspondent from Japan describes an ingenious method practised in that country for getting water from the bottom of a deep lake. For this purpose a cone-shaped earthenware bottle was employed, having a hole at its apex and a very small one at the broad part, which was stopped by a gum soluble in water. The bottle was then sunk, apex downwards, by means of a weight and a line, and allowed to remain about a quarter of an hour at the bottom of the lake, by which time the gum was dissolved and entrance for the water obtained, the air being forced out through a little hole at the bottom. It was then drawn up, and the hole at the bottom plugged with a tiny wooden peg.

ON THE MOVEMENTS OF FLUIDS IN POROUS BODIES.

Among the topics of scientific interest which awaken attention at present, is the research of Jamin, professor at the *Ecole Polytechnique*, upon the equilibrium and movement of fluids in porous bodies. The new results at which he has arrived afford an explanation of the ascent of the sap in vegetables without the necessity of recourse to the vital force. It is apparently a question of capillarity only.

Jamin has applied the new facts which he has discovered to the construction of an apparatus composed entirely of inorganic materials, but showing in its structure a great analogy with vegetables. This apparatus has the property of raising water, as trees do, to a height greater than that attained by means of atmospheric pressure, from a moist soil, whence the water is constantly drawn to the factitious leaves, where it is continually evaporated.

Reduced to its most simple form, this apparatus is composed of a block of some well-dried porous substance, as chalk, lithographic stone, etc., or a porous battery cell filled with a powder well rammed in, white chalk for instance, oxide of zinc, or even with earth. A manometer is imbedded in the interior of the mass, and the whole is plunged in a vessel full of water. The water immediately penetrates its pores and drives out the air, which, collecting in the interior, exercises a pressure upon the manometer amounting with oxide of zinc to five atmospheres, and with starch it exceeds six atmospheres. This is not the limit of the greatest possible pressure; Jamin makes known the causes which diminish it in these cases, and proves that the water is forced into porous bodies with a force which he calls π, and which is equal to that of a considerable number of atmospheres. A tube 1.20 metres long, filled with plaster and terminated at the summit by an evaporating surface, is inserted by its base into a reservoir closed and filled with water; a vacuum is caused, measured by fifteen or twenty millimetres of mercury, or by two hundred or two hundred and seventy millimetres of water; and the water appears even at the upper extremity of the tube—which proves porous bodies are able to raise water higher than can be done by atmospheric pressure. These facts cannot be explained by the ordinary laws of capillary attraction, since these bodies are not formed of impermeable tubes, but of corpuscles in juxtaposition, separated by small empty spaces. Jamin has therefore submitted the problem to the calculus, and has come to results, of which we mention the following:—

If, in a damp porous body, the water is compressed by a power of several atmospheres, it can congeal only at a temperature below 0° C.[1] Consequently old wood is able to resist frost, while young shoots, being less dense, are unable to do so.

Since water, in filtering through a porous body, is compressed as it enters, and dilates again as it runs out, it should exhibit electric currents and many other phenomena.

The theory cannot be applied to non-homogeneous porous bodies. In the extended memoir which he has prepared, Jamin discusses the complicated results which may be occasioned by irregularity of structure; he makes an application of it to wood, and shows that the interior pressure must be aug-

1 This fact has just been demonstrated by Mr. Sorby for water contained in capillary tubes of a small diameter.

mented in the denser tissues; that the air must come from the larger tubes, which cannot serve for the ascent of the sap.

It is plain that the evident tendency of all these experiments is to explain the ascent of the sap in vegetables by capillarity. The idea is not new, but it has not been hitherto fully admitted, notwithstanding the experiments which have been heretofore made.

Jamin gives it probability in showing by decisive experiments that porous bodies exercise a capillary action superior to the pressure of the atmosphere; further, he gives the physical theory of capillarity in porous bodies, and succeeds in calculating the phenomena of the movements of liquids in trees. —*Correspondence of M. Nickles with Silliman's Journal, May*, 1860.

STRENGTH OF ICE.

Recent experiments in Germany show that when the thickness of ice is an inch and a half, it will just bear the weight of a single man; when about three inches and a half, it will bear detachments of infantry, with their ranks rather wide apart; with a thickness of four and four-tenths inches, eight-pounders can be conveyed over it on sledges; five and two-tenths inches will bear twelve-pounders; eight inches will bear twenty-four-pounders; and a thickness of twelve inches will bear almost any weight.

SHOWER OF ICE.

Captain Blakiston, in a letter to General Sabine; which has been communicated to the Royal Society, dated H. M. S. Simoon, Singapore, 22d of February, 1860, gives an interesting account of a shower of ice which fell upon the ship. He says: "On the 14th of January, when two days out from the Cape of Good Hope, about three hundred miles S.S.E. of it, in latitude 38° 53′ S., longitude 20° 45′ E., we encountered a heavy squall, with rain, at ten A.M., lasting one hour, the wind shifting suddenly from east to north (true). During the squall there were three vivid flashes of lightning, one of which was very close to the ship, and at the same time a shower of ice fell, which lasted about three minutes. It was not hail, but irregular-shaped pieces of solid ice, of different dimensions, up to the size of half a brick. The squall was so heavy that the topsails were obliged to be let go. There appears to have been no previous indication of this squall, for the barometer at six P.M. on the two previous days had been at 30.00, the thermometer 70°; at eight A.M. on the 14th the barometer marked 29.82, the thermometer 70°; at ten A.M., the time of the squall, 29.86, the thermometer 70°; and at one P.M., when the weather had cleared, wind north (true), 29.76, thermometer 69°; after which it fell slowly and steadily during the remainder of the day and following night. As to the size of the pieces of ice which fell, two, which were weighed after having melted considerably, were three and a half and five ounces respectively; while I had one piece given me, a good quarter of an hour after the squall, which would only just go into an ordinary tumbler; and one or two persons depose to having seen pieces the size of a brick. On examining the ship's sails afterwards they were found to be perforated in numerous places with small holes. A very thick glass cover to one of the compasses was broken. Although several persons were struck, and some knocked down on the deck, fortunately no one was seriously injured."

ELASTICITY OF IRON.

At a recent meeting of the London Pharmaceutical Society, Mr. Appold showed the following interesting experiment, illustrative of the elasticity of iron. A stout iron ring was provided, several inches in diameter, and of such a substance as to apparently prevent the possibility of its form being in the slightest degree affected by the mere muscular force of one man; an iron rod was placed across the interior of the ring, and fitted in with sufficient tightness to retain its position without other support. Then, placing the apparatus horizontally on a table, by merely pressing with the fingers upon the outside of the ring, in a direction transverse to that occupied by the rod, the latter dropped through; proving that a certain amount of alteration had really been effected in the form of the ring by the slight pressure applied.

METHODS EMPLOYED BY THE ANCIENTS TO MOVE, HAUL, AND RAISE STONES OF UNUSUAL DIMENSIONS.

The following article, translated by J. Bennet, C. E., — Rondelet's "Art of Building," — we find in the Journal of the Franklin Institute, November, 1860: —

The immense ruins of the ancient edifices of Egypt bear witness to the taste which the Egyptians had for the grand and durable; the blocks used for their construction were of enormous size. Herodotus speaks of an edifice which formed a part of the Temple of Latona, at Buto, whose walls were formed of a single rock 52.8 feet long by as much in height. The ceiling or covering of this edifice was also a single block with 5.28 feet thickness.

In another place he says that Amasis ordered to be transported from the Isle of Eléphantine to the town of Sais, twenty days' sail distant, a structure formed of a single block of stone; its exterior length was 27.72 feet by 18.48 wide, and 10.56 feet high. The interior measured 24.86 feet in length, by 15.84 in breadth, by 6.6 in height. Two thousand men were employed three years in its transportation. The mass of this last structure, deducting the empty space within, was 2,822 cubic feet; and its weight was 458,744 pounds, on the supposition that the rock was formed of the same granite as the obelisk.

As for the other structure, which formed a part of the temple of Latona, at Buto, the Greek text of Herodotus seems to describe the four walls as being formed of a single block *hollowed like a trough*. In this case, it would have required a block of 147,200 cubic feet, with a weight of 24,260,500 pounds; and supposing it was not transported until after being hollowed, its weight would still have been 9,944,750 pounds.

The transportation of so heavy a mass and of so great volume would appear as an inconceivable difficulty, even by water, on account of the immense size of the vessel or platform required to keep afloat so great a load, which was twenty times that transported by Amasis. The difficulties of unloading and moving upon the ground so great a mass would seem to be insurmountable, as it would not be possible to find machines or rollers strong enough to bear such a weight without crushing.

The Count of Carbury, who had charge of the transportation of the rock to St. Petersburg which constitutes the pedestal of the statue of Peter the

Great, and whose weight was only 3,234,000 pounds, said that it was impossible for him to make use of rollers; even iron ones were insufficient. Balls of wrought and cast iron, which he tried to substitute for them, were flattened and broken, as well as the cushions of the same metal in which these balls rolled; only those made of a mixture of copper, tin, and calamine could resist the pressure. Still, as we cannot contradict a matter which Herodotus says he saw and regarded with wonder, we must believe that the walls of this structure were hollowed out of a mass of rock found upon the spot. This conjecture is all the more probable, as Herodotus does not mention where this enormous block came from, nor the mode of its transportation.

As for the stone which formed the upper part of the structure, it is evident that it must have been taken from another block, and that it must have been moved and raised above the walls. It was 52.8 feet long by as many broad, with a depth of 5.28 feet, making, all trimmed, a mass of 14,729 cubic feet, and a weight of 1,981,950 pounds, supposing the stone to be of a mean hardness with that used for most of the temples and for the steps of the pyramids.

A block of such dimensions must have been moved in the same position it was to have when laid. The operation required a plane and solid surface of great extent; and as wood was scarce in Egypt, we may presume, according to what Herodotus said in relation to the great pyramid of Cheops, that in these extraordinary circumstances the custom of the Egyptians was to construct large causeways and inclined planes of cut stone, upon which they hauled the enormous stones which they prided themselves on using for the construction of their edifices. These means, which would be expensive with us, were but a small matter with them, by reason of the great number of men employed upon their works, the small wages of the laborers, and the insignificant cost of the materials.

When they had to move round and unwrought masses of granite, such as are found in the quarries of Egypt, they were turned over or rolled by the force of men. In many places, far distant from the quarries, are found masses of granite whose transportation appears to have been interrupted by some unforeseen circumstance.

As for the blocks which do not come in this kind of transportation, and whose surfaces were plane, as that which served for the covering of the temple at Buto, and the monolithe structure of Amasis, we believe that they made use of rollers and capstans, the most simple and ancient machines, the most powerful and speedy in their effects. To give our ideas upon this, we report the result of an experiment made upon this subject with a cut stone weighing eleven hundred and sixty-five pounds.

To drag this stone upon a horizontal surface of the same material, and coarsely cut, required eight hundred and eighteen pounds.

The same drawn upon pieces of wood exacted a force of seven hundred and three pounds.

The same placed upon a wood platform, and drawn upon wood, required a force of six hundred and fifty-four pounds. But soaping the two surfaces which slid upon each other, there was only needed one hundred and ninety-six pounds.

This stone put upon rollers 3.2 inches diameter, and set in motion upon a surface of the same material, required only a force of 36.68 pounds; the same rolling upon pieces of wood yielded to an effort of 30 pounds; and when the rollers were put between two pieces of wood 23½ pounds sufficed.

It follows from this experiment that to draw a rough stone upon a firm and smooth bottom there is needed a little over $\frac{2}{3}$ of its weight; $\frac{3}{5}$, if the surface is of wood; $\frac{5}{9}$, if the movement is made of wood upon wood; and if the two sliding surfaces of wood are soaped, but $\frac{1}{6}$. But if we use rollers placed immediately between the stone and ground there will be required a little over $\frac{1}{32}$ of the weight, and $\frac{1}{40}$ if they roll upon wood; and, finally, if they roll between two smooth wooden surfaces there will be needed but about the $\frac{1}{50}$ of the weight.

Still it is proper to remark, that as woods compress under great loads, the rollers made of this material are subject to a change of form, to be crushed, and to sinking in the pieces between which they are placed. This produces a friction, whose effect increases with the load. To raise the obelisk at the square of St. Peter's, in Rome, which, with all its fixtures, weighed 829,250 pounds, there were required forty capstans, and to draw it upon a horizontal plane with rollers placed between two wooden surfaces it only needed four; whence it follows in this case that the force was but the $\frac{1}{10}$ part of the weight, while the experiment above cited gives a little over the $\frac{1}{50}$ part. But Fontana, who superintended this operation, observed that most of the rollers, which were seventy in number, were crushed, and that the others sank into the pieces of wood between which they were placed.

To have the full benefit of the rollers they should be as incompressible as the surfaces between which they move. Granite rollers, between surfaces of the same material, to prevent breaking should be very short, and their number great, to have as little of the load as possible on each. The length should not be over one and a half diameters. When the stone has considerable width they must be set in many rows. This method, if practicable, would have been preferable to the balls which the Count of Carbury used for the transportation of the rock which served for the base of the equestrian statue of Peter the Great; they required the $\frac{1}{22}$ part of the weight.

From the results of these experiments, and the observations to which they give rise, we may calculate the force required to transport the stone which formed the monolithe structure at Saïs, and the covering of the temple at Buto.

Experience with works has taught us that a man of medium strength, and used to work like those employed by the ancients, can carry a load equal to his weight, and haul one and a half times as much; so that for the stone cover of the temple at Buto, whose weight we have estimated at 1,981,950 pounds, there would be required 10,000 men to draw it upon a smooth and solid ground; 9000 to draw it upon a surface formed of pieces of wood; 8333 if the stone was put upon a wood platform and drawn upon wood; and only 2500 men if care was taken to soap the two surfaces which slid upon each other.

The block being 52.8 feet wide, the men could easily be disposed in forty rows, which for the first case would require 250 in each row, in case they were equal, and much less if they diverged; 225 for the second; 208 for the third; and 62½ for the fourth: the last is the most practicable method.

The great breadth of this stone and its weight would make it impossible to use wooden rollers. As for those of granite, if the ground were firm and smooth enough to make use of them, 300 men, or seven and a half rows, would have sufficed to move the load. But it is not likely that this method was adopted, on account of its great expense. It is much more probable that they made use of capstans.

Supposing a simple capstan, traversed by two levers, with a mean length at the point of application of the resultant force of ten times the diameter of the drum, each man makes an effort which may be valued at 539½ pounds. If twelve men work each capstan, their effort will be 6474 pounds, which gives in the first case, when a force equal to two-thirds of the load is required, 2400 men and 200 capstans; for the second case, 2160 men and 180 capstans; for the third, 2000 men and 166 capstans; and for the fourth, 600 men and 50 capstans.

By the use of pulleys and muffles the number of men and capstans may be reduced one-half or a quarter.

The results here shown indicate the force necessary to move the block upon a horizontal plane; but as it had to be raised above the walls of the temple which it served to cover, in raising it upon an inclined plane it is evident that the force must be increased in the ratio of its inclination.

UNIFORM MUSICAL PITCH.

The committee appointed a year ago by a general meeting of musicians, and others interested in music, assembled in London, to consider the subject of the present state of musical pitch in England,[1] have recently reported, substantially as follows: —

The committee found, after a little inquiry, that their attention would have to be directed to three principal points: — 1. Whether a uniform musical pitch was desirable. 2. Whether a uniform musical pitch was possible. 3. Supposing a uniform pitch to be desirable and possible, what that pitch should be.

1. With the first of these considerations the committee was not long occupied, all testimony going to prove the frequent inconvenience to which musical performers, vocal and instrumental, musical instrument-makers, musical directors, and even instructed hearers, were alike put by variations in the pitch, whether of individual instruments or of entire orchestras. The committee came early to a unanimous resolution that a uniform pitch was desirable.

2. The second question, "whether a uniform pitch was possible," was not found to admit of so ready an answer as the first. That a uniform pitch is never for any length of time maintained is well known to all practical musicians. The effects of temperature on musical instruments are so great and so rapid, that a difference in pitch of at least a quarter of a tone has often been remarked between the beginning and the end of the same concert; and instruments not required at the beginning of a performance are frequently tuned to a higher pitch in order to meet this anticipated elevation. In theatres, instruments to be used on the stage are systematically tuned sharper than those to be used in the orchestra, to compensate for the difference of temperature before and behind the scenes. Still, though the maintenance of a certain pitch may be difficult, or even impossible, the definition of it is not. A point of departure, if nothing more, would be in the highest degree convenient to musicians. No great practical inconvenience has ever been found to result from any change of pitch possible during a single performance. It is against the gradual elevation, consequent on the absence of any recognized standard, that musical practice requires a security. Physical science is, happily, enabled to afford this, and to bring to the aid of musical

[1] See Annual of Scientific Discovery, 1860, pp. 188-191.

art more than one process by which such a standard may be adjusted. Musical pitch is not a matter of mere comparison. A sound is not merely acute or grave in relation to another; its pitch is capable of exact measurement, and that measurement once recorded, it may be reproduced at any distance of time, without reference to any other sound whatever. In short, the number of vibrations per second due to a given sound can be ascertained with the same certainty as the number of square yards on a given estate, or the number of tons burthen of a given merchantman. Several methods of counting vibrations have been adopted by men of science at different periods, by one or other of which the pitch of certain notes (generally either C or A) in this or that musical establishment has been recorded; so that a body of evidence exists, in addition to, and independent of, that of tuning-forks, bells, and other instruments least susceptible of change, by which the variations of pitch, at different times and in many different places, may be ascertained with certainty. Under these circumstances the committee came to a resolution that a uniform pitch was not only desirable but possible. It remained for them to consider "what that pitch should be."

3. On this question such very wide difference of opinion was expressed, and, indeed, such very conflicting evidence was adduced, that the committee concluded to make no formal recommendation. They say, however, that, on grounds of abstract propriety, they were inclined to recommend the pitch of C 512 for general adoption, were there not certain practical considerations in opposition to any change. Thus, they say, it is certain that a change from the present pitch of C 546 to C 512 — a change of about a semitone — could not be made without great inconvenience and pecuniary loss to the body with whom the adjustment of the pitch practically rests, — our orchestral performers. Such a change, too, would fall heavily on musical instrument makers, probably to the extent, in many cases, of rendering the greater portion of their existing stock valueless. This objection, it is thought by some even of those who are most anxious for a great depression of the present pitch, would be fatal to any proposition which did not in some way meet it.

In conclusion, the committee call attention to the suggestions made by the congress of musicians which assembled at Stuttgard, in 1834, which body recommended a pitch of 528 for C, = 440 for A, basing their calculation on a thirty-two feet organ-pipe, giving thirty-three vibrations per second instead of thirty-two. The following would be the scale at this pitch — the only one yet proposed which gives all the sounds in whole numbers: —

C	D	E	F	G	A	B	C
264	297	330	352	396	440	495	528

This pitch, of which the C is sixteen vibrations per second higher than that of C 512, and eighteen vibrations lower than the C at the present pitch (of 546), is as near as possible half-way between the two latter, and, therefore, a quarter of a tone above the one and a quarter of a tone below the other. To lower the stringed instruments to this pitch would obviously be attended with little difficulty. Depression to the extent of a quarter of a tone is said to be easy with the brass instruments and possible with the wooden wind instruments — the flutes, oboes, clarinets, and bassoons — now in use. Few organs exist of higher pitch than the Stuttgard, and the raising of those which have been tuned to C 512 would not be attended with serious difficulty. The Stuttgard pitch, then, if not the very best that could be conceived, may be regarded as the one which, with many recommendations, would have the

best chance of attaining the general assent of contemporary musicians. Though higher than the pitch of 512, the Philharmonic pitch, or the diapason normal, the Stuttgard pitch is but a few vibrations higher than the last two of these, — one of which experience has proved to be a good pitch for instrumental music. It is a quarter of a tone below the present pitch, by general consent voted intolerably high. Its adoption would involve little, if any, inconvenience or pecuniary loss to instrumental performers or makers of musical instruments. It would, therefore, be likely to meet the support of the majority of those interested in the question of pitch.

INTENSIFICATION OF SOUND: THE PHONOSCOPE AND HYDROPHONE.

Dr. Scott Alison has read to the Royal Society a paper "On the Intensification of Sound through Solid Bodies, by the interposition of water between them and the distal extremities of Hearing-Tubes." The author gives an account of various experiments which he has recently made on sounds proceeding through solid bodies. He has found that sounds which are faint, when heard by a hearing-tube applied directly to solid sounding bodies, become augmented when water is interposed between these bodies and the distal extremity of the hearing-tube. He has been able, by the employment of water, to hear the sound of a solid body, such as a table, which without this medium has been inaudible. Experiments have been made upon water in various amounts and in different conditions. Thus a very thin layer, a mere ring round the edge of the hearing-tube, masses of water in larger or smaller vessels, and a bag of water, have been employed. The results have been the same as regards augmentation. The degree of augmentation was greatest when the hearing-tube was immersed freely in water. In experimenting upon water in vessels, it was found necessary to close the extremity of the tube to be immersed, by tying over it a piece of bladder or thin India-rubber; for the entrance of water into the interior interfered greatly with the augmentation.

The effect of water in augmenting sound is materially reduced if even a small amount of solid material be interposed between the water employed and the mouth of the hearing-tube. A piece of wood, not much thicker than a paper-cutter, materially interferes with the augmenting power of water. The augmentation of sound thus obtained by water seems to be due to the complete fitting of the liquid on the solid body, and also round the mouth of the hearing-tube, whereby the column of air is thoroughly enclosed; also to the less impediment to the vibrations of the instrument when held in contact with water than when held in contact with a solid body, the water yielding in a greater degree than a solid.

The mode of judging of the augmentation was twofold: first, one sensation was compared with another perceived by the same ear, the one sensation following immediately upon the other; second, the differential stethophone was employed, by which two impressions are simultaneously made upon the two ears; in which case, if one impression be materially greater than the other, sound is perceived in that ear only on which the greater impression is made. To obtain the advantage of the differential stethophone, or "Phonoscope," as it might here perhaps be more correctly designated, when sounds at some distance from the ear were being examined, its length was increased by the addition of long tubes of India-rubber.

Experiments were made upon other liquids besides water, such as mercury and ether.

Other materials besides liquids were found to afford a similar intensification of sound from solid bodies, such as laminæ of gutta-percha or of India-rubber and sheets of writing paper, but the amount of augmentation was less.

The hearing-tubes employed were various. Many of the experiments were performed with the author's ordinary differential stethophone, an instrument described in the *Philosophical Magazine* for November, 1858. India-rubber tubes fitted with ivory ear-knobs, and with wooden or glass cups (the size of the cup, or object-extremity of ordinary stethoscopes), and having an ear-extremity to pass into the meatus, and brass tubes, were also in turn employed. Tubes closed at their distal extremity with solid material, such as glass, did not answer so well as those closed with membrane.

The water-bag increases the impression conveyed to the ear by the wooden stethoscope, if it be placed between the flat ear-piece and the external ear. It may be employed alone to reinforce sound. The name of *Hydrophone* has been given to it.

A postscript is added, in which the author records an experiment made on the bank of the Serpentine river. A sound produced upon the land was heard at a point in the water when it could not be heard at an equal distance on the ground, if the two limbs of the differential stethophone were employed simultaneously.

The sensation upon the ear, connected by means of a hollow tube with water in sonorous undulations, was found to be much greater than that upon the ear connected with the same water by means of a solid rod. When both tube and solid rod were employed simultaneously, sound was heard in that ear only supplied with the tube.

ON THE REGISTRATION OF SOUND VIBRATIONS.

The Abbé Laborde has recently devised the following plan for registering the vibrations of sound. To the ceiling of a room are fixed two rings, some six feet apart, and to these are suspended two wooden rules, about eight feet long. Their lower ends are fastened into a block or wood, which is connected with a pendulum, so that the vibrations may be registered on a piece of glass, the face of which is covered with smoke black. From this photographic impressions may be multiplied, if desirable, to any extent. This apparatus is much less costly than any other hitherto made for registering sounds, and is interesting, since it is an aid toward the invention of machines which shall gradually advance from registering sounds to registering syllables and words. As soon as the wit of man has invented a machine as delicate as the human ear, we can have reporting machines. The idea is certainly far less astonishing than that of the daguerreotype before its invention. If the vibrations of light, so much finer than those of sound, are made to register themselves with such wonderful accuracy, why may not the vibrations of sound be made to do the same!

FIGURES PRODUCED BY SOUND.

If a drinking glass, or a funnel of about three inches diameter at the edge, be filled with water, alcohol, or ether, and a strong note be made by draw-

ing a violin-bow on the glass, a sound-figure will be formed on the surface of the liquid, consisting of nothing but drops of liquid. If the vessel gives the fundamental note, the figure forms a four-rayed star, the ends of which extend to the four nodal points; but if the note which the vessel gives be the second higher, the star will be six-rayed; and if the vessel gives still higher tones, other more numerously rayed stars are produced. — *Poggendorff's Annalen.*

THE POWER OF A BIRD'S SONG.

When we hear the song of a soaring lark, we may be sure that the entire atmosphere between us and the bird is filled with pulses, or undulations, or waves, as they are often called, produced by the little songster's organ of voice. This organ is a vibrating instrument, resembling in principle the reed of a clarinet. Let us suppose that we hear the song of a lark, elevated to a height of five hundred feet in the air. Before this is possible, the bird must have agitated a sphere of air one thousand feet in diameter; that is to say, it must have communicated to 17,888 tons of air a motion sufficiently intense to be appreciated by our organs of hearing. — *Prof. Tyndall.*

ON THE VELOCITY OF SOUND.

It has generally been considered that sound moves at a uniform velocity of 1,142 feet per second; and in every book on the subject rules are given by which the distance of any source of sound, such as a firearm or a flash of lightning, may be ascertained by estimating the number of seconds and fractions of a second which elapse between the ocularly-observed time of the occurrence of the phenomenon and the hearing of the sound which accompanies it. Doubtless many persons have in this manner amused themselves by estimating the distance off which certain violent lightning flashes must have been, and have taken comfort from the idea that, if a certain number of seconds have elapsed *after* the flash has taken place before the thunder is heard, they are safe from its effects; falling into the very common error of mistaking the cause for the effect. The Rev. S. Earnshaw has, however, been engaged in some extremely interesting mathematical investigations respecting the phenomenon of sound, and has arrived at the theoretical conclusion that violent sounds are propagated far more rapidly than gentle sounds, and that therefore all reasoning upon the distance of the flash, based upon the lapse of time between it and the thunder, is fallacious. Many instances of this fact are adduced in corroboration of the theory, in which the clap of thunder followed immediately after the lightning, when, judging from the distance which the latter was from the observer, there should have been an interval of many seconds duration. These and similar instances have induced the above-named gentleman to enter upon a mathematical investigation of the theory of sound, and he arrives at the conclusion, contrary to the hitherto universally received opinion, that there is no limit to the velocity with which a violent sound is transmissible through the atmosphere, provided the phenomenon which produces the sound be sufficiently violent. Hence, it is probable that there is no sound which is propagated faster than a clap of thunder, its genesis being especially violent. This theory seems also capable of explaining the rumbling, rolling noise of thunder. It is only necessary to imagine that the sound at its origin is broken up, either by partial interruption or reflection, into several sounds of differ-

ent degrees of violence. They would thus be propagated with different degrees of rapidity, and would therefore not fall upon the ear, if it were at any distance off, with a sudden crash, but in a series of minor claps, or as a rattle. If this theory be true, the report of a cannon should travel faster than the human voice, and that of thunder faster than either. — *London Photographic News.*

CHROMO-TYPOGRAPHY.

M. Rochette has devised a new method of printing the different colors used in this art. Instead of applying a series of plates or stones, each bearing one color, in the usual way, he arranges his plates upon a rotating platform, of smaller dimensions, but like those used on railways. Suppose four plates thus arranged with black, red, blue, and green, and a sheet of four pages, which it is desired to print, imposed upon them. One page will be printed in each color, and by turning the sheet a quarter round each time, the remaining colors will be printed in succession. This apparatus has a mechanical contrivance to ensure accuracy of position; and, as the colors admit of super-position, green may be formed by successive printings of yellow and blne, orange by yellow and red, etc.

ON THE SOLUTION OF ICE IN INLAND WATERS.

In a paper read before the American Association for 1860, by Mr. B. F. Harrison, a theory to account for the sudden disappearance of ice in inland waters was presented, which was based upon a series of observations made upon a little lake in Connecticut, which is so hedged in that only the south and southwest winds blow upon it. It is not fed by any large stream, and has a small outlet. On the twenty-third day of January, 1860, he visited the lake, and found the ice ten or eleven inches thick. He found, at a station on the lake, the temperature of the water directly under the ice to be thirty-four degrees; three feet down, thirty-eight; twelve feet, forty-one; the bottom of the lake, forty-three and a half; mean temperature, thirty-eight and seven-eighths. On the sixth of March he found the ice disappearing very rapidly, as much as one-third disappearing during the two hours that he remained by the lake. The mean temperature of the lake on this date was forty-one and a half. The conclusion arrived at was, that the solution of the ice is caused by heating up the water from the bottom, since the warmth could not have been communicated from the atmosphere, its temperature being lower than the water. The mean temperature of the earth at a depth of twenty feet furnishes a vast magazine of heat, that is immediately effective as soon as the cold from the atmosphere ceases to be intense.

THE GREAT PYRAMID.—WHY, AND WHEN, WAS IT BUILT?

The above is the title of a volume recently published in London by John Taylor, a gentleman of an exceedingly original mind, and favorably known in literary and scientific circles. His researches and speculations, whether leading to any truthful result or no, will at least be found interesting and curious:—

Of all the records of their existence, which the men of ages long gone by have left upon the face of the earth, none, perhaps, is so eminently calculated to excite universal interest, or to give rise to enthusiastic speculation,

as the pyramids of Egypt. It would scarcely be possible for even the least curious and impressionable of men to gaze with his own eyes upon those mighty masses, or even listen to the descriptions of them which have been given by numberless travellers, from the time of Herodotus down to the present day, without, when the first feeling of almost stupefied admiration had subsided, experiencing an irresistible impulse to ask the two questions which, in his present volume, Mr. Taylor attempts to answer. And of all possible methods of proceeding to the solution of these inevitable queries, that adopted by Mr. Taylor is certainly the most thoroughly trustworthy and reliable. It consists in placing, so to speak, the Great Pyramid itself in the witness-box, and, step by step, eliciting its history from its own mouth. Mr. Taylor has never himself visited the pyramids; but he deduces his conclusions from a careful collation of the chief existing records on the subject, from the earliest period down to the present time. So far from considering his want of personal acquaintance with the object of his inquiry as likely to be in any degree prejudicial to its success, he is inclined to regard this circumstance as a subject rather for congratulation than for regret.

With regard to the first of the two questions propounded by Mr. Taylor, an immense majority of those who have inquired into the subject concur in the opinion that the pyramids of Egypt were designed as the burial-places of the kings by whom they were built. A long succession of travellers, from Strabo and Diodorus Siculus to Dr. Robinson and the Rev. A. P. Stanley, have agreed without hesitation in adopting this view. So long ago, however, as the commencement of the present century, a different theory was started by some of the scientific men who accompanied the French expedition to Egypt, viz., that the three largest pyramids were constructed on certain geometrical principles, and were intended to perpetuate the memory of the standard by which they were built. This hypothesis was very coldly received at the time of its first suggestion, and it was not till the publication, in 1840, of Colonel Howard Vyse's researches on the pyramids that it attracted public notice to any appreciable degree; but it has at length found a zealous champion in Mr. Taylor, who, by a careful examination of all existing records on the subject, endeavors to show that, when rightly understood, they tend, one and all, to its complete confirmation. Although he seems inclined to extend this theory to the two smaller pyramids of Gizeh, it is only in the case of the Great Pyramid that he prosecutes his inquiries in detail. Obviously, the first things to be done in such a case are to ascertain the exact dimensions of the pyramid in its perfect state, and to reconcile, in some reasonable manner, the conflicting measurements which have been assigned to it from time to time by various observers. The latter of these two objects Mr. Taylor effects with a great show of probability, by pointing out that it is only within a recent period that the true base of the pyramid has been reached, and that the smaller and earlier measurements were made at times when the lower tiers of the edifice were more or less covered up with sand and *débris*. With regard to the former point, it has long been suspected that the present condition of the pyramid is far from being that in which it was left by its builders, and that it was originally a perfect pyramid, with sharp angles and terminating in a point. This suspicion received a strong confirmation in 1799, when M. Le Père and Colonel Coutelle, in surveying the platform on which the pyramid was founded, discovered at both the northeastern and northwestern angles a wide shallow socket, which seemed to have been designed for the reception of a corner-stone; and it was finally

converted into a certainty in 1837, when Colonel Vyse discovered two of the casing-stones, actually *in situ*, nearly in the centre of the northern face of the pyramid. The angle at which these casing-stones are inclined (51° 50′) and the length of the base (764 feet) being both known, the total height of the pyramid is easily ascertained, and all its dimensions are then satisfactorily determined. They are as follows:

	Feet.	Inches.
Length of former base, including casing-stones,	764	
Length of present base,	746	
Former height, including casing-stones,	480	9
Present height, perpendicular,	450	9
Former height, inclined,	611	
Present height, inclined,	568	3
Width of pavement in front of casing-stones in centre of northern side,	33	6
Thickness of paving-stones,	1	9

	Acres.	Roods.	Poles.
Former extent of base,	13	1	22
Present extent of base,	12	3	3

The angle of the casing-stones being 51° 50′, and the base 764 feet, the height of the pyramid, supposing it to end in a point, would be 486 feet. "What reason," asks Mr. Taylor, "can be assigned for the founders of the Great Pyramid giving it this precise angle, and not rather making each face an equilateral triangle? The only one we can suggest is, that they knew the earth to be a sphere; that they had measured off a portion of one of its great circles, and, by observing the motion of the heavenly bodies over the earth's surface, had ascertained its circumference, and were now desirous of leaving behind them a record of that circumference as correct and imperishable as it was possible for them to construct. They assumed the earth to be a perfect sphere, and as they knew that the radius of a circle must bear a certain proportion to its circumference, they then built a pyramid of such a height, in proportion to its base, that its perpendicular would be equal to the radius of a circle equal in circumference to the perimeter of the base. How the thought occurred to them we cannot tell; but a more proper monument for this purpose could not have been devised than a vast pyramid with a square base, the vertical height of which pyramid should be the radius of a sphere in its circumference equal to the perimeter of the base. It was impossible to build a hemisphere of so large a size. In the form of a pyramid all these truths might be declared which they had taken so much pains to learn; and in that form the structure would be less liable to injury from time, neglect, or wantonness, than in any other."

Now, the exact angle which must be given to the face of a pyramid, in order to enable it to fulfil these conditions, is 51° 51′ 14″; to which the observed angle of 51° 50′ is as near an approach as the magnitude of the work would probably allow. As a further proof that this coincidence in the angles was not accidental, Mr. Taylor refers to the statement of Herodotus, which he gathered from the official guardians of the pyramid at the time of his visit, that "each face of the pyramid is eight plethra, and the height is equal." He concludes that this measurement refers, not to linear but to square measure; and that the statement signifies that the number of square feet in each face of the pyramid is equal to the square of the height. Now,

the angle of inclination necessary to ensure this proportion is 51° 49′ 46″; which is again a very close approximation to the observed angle of 51° 50′. The proportion of the circumference of a circle to its diameter is 3.1415927 to 1. The perpendicular height or radius of the pyramid being 486 English feet, its diameter is 972 feet; and its perimeter is four times 764, or 3056 feet. Taking the diameter as unity, we have 1000 feet of .972 of the English foot, and in the circumference 3144 of the same feet. The true proportion in a sphere would be 3141.5927 feet, about 2½ feet less than the actual measure. This foot of .972 of the English foot is precisely the larger Roman, or Italian, foot, whose connection with the pyramid measure is thus established. By a series of elaborate but very interesting calculations, Mr. Taylor shows that the different ancient feet with which we are acquainted, as well as the English foot, are similarly connected with the pyramid measures. Thus the foot of Drusus or of Diodorus Siculus, which is 1.0909 English feet, is contained 700 times in the length of the base of the pyramid, and 120 million of times in the circumference of the earth, as given by Eratosthenes; and it is that measure of the circumference of which 363,636 feet constitute a degree. This is actually the length of the degree in the latitude of the Great Pyramid. The circumference of the earth being 120,000,000 Egyptian feet, the diameter would be about 38,200,000 feet, or 458,400,000 Egyptian inches, numbers which furnish no principle of unity as a measure of the diameter. If, however, we express the diameter of the earth in English, not in Egyptian, feet, we have 41,672,380 feet, or 500,068,560 inches; and the circumference is 130,908,000 English feet, or 1,570,896,000 inches. Doubling this last number, we have 3,141,792,000 English inches; and dividing 130,-908,000 by 3.141792 (instead of 3.141592) gives us 41,666,667 English feet, or 500,000,000 English inches, for the diameter. Hence, at the building of the pyramid, the diameter of the earth was indicated by 1, when its circumference was represented by 3.141792 (the actual proportion of the diameter of a sphere to its circumference being 1 to 3.141592). These numbers are double the actual measure, which therefore allows 500,000,000 inches for the diameter, and 1,570,896,000 for the circumference. But these inches are English inches; whence Mr. Taylor concludes that the English inch was invented at this early period to express the 500 millionth part of the diameter of the earth. Not only all the ancient feet with which we are acquainted, but also all the cubits which we find mentioned in the Scriptures and elsewhere, are, according to Mr. Taylor, connected with the pyramid measure; but we have not space to detail the connection in each case.

Having thus concluded, from the exterior measurements of the Great Pyramid, that it was designed as a record of the dimensions of the earth, it now remains to inquire what we can learn from its interior. The only object as yet discovered inside the pyramid is an oblong coffer, shaped like a trough or hot-bath, hollowed with the greatest accuracy out of a solid block of porphyry, and placed in what is known as the King's Chamber. This coffer has generally been regarded as designed for a sarcophagus. But, from a consideration of its dimensions, as recorded by Colonel Vyse, Mr. Taylor arrives at a very different conclusion. It is 78 inches long, 26.5 wide, and 34.5 deep; and its cubic content is consequently 71,311.5 inches. Now the cube of the Karnak cubit of 41.472 inches is 71,328.8, a number so near to that expressing the cubic content of the coffer, that Mr. Taylor concludes that the true capacity of the coffer is a cubic Karnak cubit, and that it is designed to be a standard measure of capacity. He traces its connection

with the Hebrew, Greek, and Roman measures, and, finally, with those which are in use amongst us at the present day. This portion of his inquiry is so curious and interesting as to deserve extraction: —

"But no nation, ancient or modern, is so remarkable for having preserved a close agreement with the pyramid coffer as our own. First, our peck of wheat, like the hecteus and modius, is contained 128 times in that coffer; secondly, thirty-two of our bushels of wheat, or four of our quarters of wheat, would fill a vessel of that same capacity if we had one still in use; but, thirdly, though a vessel of this capacity is not in existence with us at present, we must have had such a measure in earlier times, since we make daily reference to it: for, when we say eight bushels of wheat are a quarter, we affirm it to be a fourth part of some entire measure, which is exactly equal in capacity to the pyramid coffer.

"This measure was our chaldron, in Latin *caldarium*, a hot bath; and though our measure was never used as a bath, we cannot wonder that such a name was given to the vessel, if it resembled, as it probably did, the pyramid coffer, for that is made exactly in the form of a hot bath. But no other nation, as far as we can ascertain, has ever made use of such a measure of capacity besides the English, and given it a name so exactly corresponding with that which would be a true description of the pyramid coffer. The *laver* of the Scriptures represents the same vessel in size and shape, but it was not used as a measure of capacity. The Roman *labrum*, which is the same word as laver, was applied to a bath in which a person may recline or bathe; as also to a wine-vat, but not to a measure of capacity; and, probably, in no other country than our own is the word *chaldron*, which means a hot bath (as the word caldron means an iron or copper vessel containing hot water), retained as the proper term for a measure of capacity, precisely equal to that of the pyramid coffer. By these several minute and singular coincidences, the English nation appears to be more closely identified with the people who founded the Great Pyramid than many of those nations of antiquity who were apparently brought into closer contact with Egypt in the earliest ages."

He also traces to the coffer the distinction between Troy and Avoirdupois weight: —

"As the pyramid coffer contains 18,005,760 Troy grains, or 18,000,000 grains (omitting 5760 grains, equal to one pound), so it contains 3125 pounds Troy of 5760 grains. But this is the weight of water. If the coffer were filled with wheat the weight would be only 2500 pounds, or one-fifth less. Accordingly, 10 pounds Troy of water would occupy the space of 8 pounds Troy of wheat. The coffer was probably intended for a corn measure in the first instance; but it was also found that the same vessel, which would hold 2500 pounds of wheat, would hold 3125 pounds of water or wine. Hence any vessel of capacity which would hold 10 pounds of 5760 grains was considered to hold 8 pounds of 7200 grains. This was the original, in all probability, of our Avoirdupois pound.

"The name of *Avoirdupois* does not appear to have been given to any kind of weight in England earlier than the ninth year of Edward the Third. It is again mentioned in the twenty-fourth year of Henry the Eighth, when a statute directs 'that beef, pork, mutton, and veal shall be sold by weight, called Averdupois;' whence we may infer that butchers' meat had previously been sold by Troy weight. If there was an older weight which expressed the relation that water was supposed to bear to wheat, when both

occupied the same space, viz., that of 5 to 4, or 7200 grains to 5760 grains, no other peculiar name for it has come down to our times.

"But there was, from the earliest ages, a different pound from the Troy pound made use of, by which the merchant bought his goods; and his profit was obtained by selling them again at the same price in a less pound. This pound was called the merchant's pound. Its ounce was the same as the Troy ounce of 480 grains, but, instead of 12, it contained 15 ounces. Fleta says, '*quindecim unciæ faciunt libram mercatoriam*,' — '15 ounces make the merchant's pound.' It was equal, therefore, to 7200 grains Troy; but its object was not to represent the comparative weight of wine and wheat, or water and wheat, but to give an advantage equal to 20 per cent, or one-fifth, to the merchant or wholesale buyer, in making his purchases. He sold his goods at the same price per pound at which he bought them, the increment of 3 ounces in 15, or 20 per cent, being his profit. Further advantages were also given him; as when 112 and 120 pounds were in some cases reckoned to the 100 pounds, on his taking a large quantity. Thus the merchant's pound was a sort of rough wholesale pound, in which small amounts were disregarded, these being designed to be given to the merchant; and hence it was that the Avoirdupois pound, when it was established, took no cognizance of any weight below a scruple. In goods not weighed but counted, a larger number was allowed the merchant at the retail price of the smaller number."

Even the term Troy-weight is, according to Mr. Taylor, derived from the coffer, being a corruption of Trough-weight.

With regard to the second question investigated by Mr. Taylor, When was the pyramid built? our limited space forbids further notice.

CHEMICAL SCIENCE.

CHEMICAL ANALYSIS BY OBERVATIONS OF SPECTRA.

It is well known that many substances when introduced into a flame possess the property of causing in the spectrum certain bright lines. Bunsen and Kirchhoff have based upon these lines a method of qualitative analysis which materially extends the domain of chemical reactions, and leads to the solution of many difficult problems. In a memoir recently published (and an abstract of which may be found in Silliman's Journal for November, 1860), the authors develop in detail the method to be pursued in the examinations of the metals, of the alkalies, and alkaline earths. They show, in the first place, that the different states of combination of the metals examined, as well as very great differences of temperature in the flames produced, exert no influence on the position of the spectral lines corresponding to the particular metals. The same metallic compound gives a spectrum which is the more intense the higher the temperature of the flame; moreover, the most volatile compound of any particular metal always gives the greatest intensity of light.

When small pieces of potassium, sodium, lithium and calcium are attached to the extremities of fine platinum wires enclosed in glass tubes, and the spark of a Ruhmkorff's induction-apparatus is allowed to pass from one pole to the other, the spectra are found to contain the same bright lines as the flames. From this, it appears that these bright lines may be looked upon as certain indications of the presence of the metals in question. They serve as reactions by which these substances may be recognized more sharply, more quickly, and in smaller quantities, than by any other analytical process.

This analysis of the chemical composition of substances promises to furnish also a method of investigating the chemical nature of the atmospheres of the sun and of the brighter fixed stars. Kirchhoff has shown, from theoretical considerations, that the spectrum of an ignited gas is inverted when a source of light of sufficient intensity, and giving a continuous spectrum, is placed behind it. In other words, the bright lines are under these circumstances converted into dark ones. From this it appears that the solar spectrum, with its dark lines, is nothing else than the inversion of the spectrum, which the atmosphere of the sun would show by itself. The chemical analysis of the sun's atmosphere requires us, therefore, only to determine what substances introduced into a flame will produce bright lines, corresponding to the dark lines in the sun's light. The authors have verified by direct experiment the

above conclusions, and have inverted the bright lines of potassium, sodium, lithium, calcium, strontium, and barium. They promise a further extension of their very beautiful and valuable investigations. — *Pogg. Ann. June*, 1860, *et Silliman's Journal, November*, 1860.

ON THE PROBABLE COMPOUND NATURE OF SOME OF THE SO-CALLED "ELEMENTS."

An interesting and elaborate paper by Gustav Tschermak, published in the Proceedings of the Academy of Science of Vienna, and extracted in an abridged form in Knop's Centralblatt (July 4, 1860), on the subject of the law of volumes of liquid chemical compounds, affords a support to the views expressed by Mr. Lea, of Philadelphia, and others, "that those bodies which we have as yet failed to decompose we have not found to be elementary." The author therein shows that many of the substances usually classed as elements comport themselves in the physical properties exhibited by their combinations as compound bodies, and that it is possible from these physical properties to determine (hypothetically) the number of "physical" or absolute atoms which he supposes to be contained in a chemical atom of such body or pseudo-element. He endeavors to show that it is possible to calculate the specific gravity of a liquid from its atomic weight and the number of simple (chemical) atoms in its compound molecule as data, but that the results lead to the immediate inference that each chemical atom contains, with few exceptions, several physical atoms.

The particulars of the theory of M. Tschermak, and the results deduced by him, are too technical for presentation in the present volume; but a further reference to them may be found in Silliman's Journal for November, 1860, in a paper communicated by M. Carey Lea, of Philadelphia, on the subject.

ON THE NUMERICAL RELATIONS EXISTING BETWEEN THE ELEMENTS.

In the *Annual of Scientific Discovery* for 1860, we published an abstract of a paper, by M. Carey Lea, Esq. (contributed to *Silliman's Journal*), setting forth some exceedingly curious numerical relations existing between the equivalent numbers of the so-called elementary bodies.[1] In the May number of the same Journal we find an additional paper by the same author, in which a new species of relation between the equivalent numbers of the elements is pointed out, wholly distinct, it is believed, from any hitherto noticed, and which Mr. Lea terms "*Geometrical Ratios.*"

"The arithmetical relations between the equivalent numbers of the elements," says Mr. Lea, "are susceptible of at least an hypothetical explanation, on the supposition that the common difference in a series of elements may represent the equivalent numbers of a substance as yet undetermined, which, by its combinations in varying proportions, gives rise to the bodies constituting the successive terms of the series. The new analogies, on the contrary, are more difficult of explanation, even by hypothesis. Their accuracy, sometimes absolute, renders improbable the supposition that they are mere casual coincidences.

"The nature of these relations consists in this, that if we take two substances, and examine the ratio which subsists between the numbers representing

[1] See Annual of Scientific Discovery for 1860, pp. 279–283.

their atomic weights, we may find, in certain cases, that it is identical with the ratio subsisting between the atomic weights of two other substances, and so on through a considerable number of elements. The ratio between the atomic weights, for instance, of oxygen and nitrogen, is that of four to seven, so likewise is that between those of zirconium and potassium, potassium and barium, with absolute exactitude. What renders this the more remarkable is, that all three of these last substances are striking exceptions to Prout's law, that the equivalents of the elements are exact multiples of that of hydrogen; they all have decimals, zirconium 22.4, potassium 39.2, barium 68.6. Now, the ratio just mentioned gives these numbers with their decimals with perfect exactness. The same species of relation also exists between many other elements.

"Again, the atomic weight of carbon stands to that of nitrogen in the ratio of three to seven, a proportion which is found exactly or approximately to extend to certain other elements. Apart, also, from these more general ratios, many elements may be classed together in double or treble pairs, such that the two elements in one pair stand to each other in the same numerical ratio as the two elements of a second or third pair, the two elements constituting each pair being more or less closely allied to each other in properties, though the pairs are not necessarily analogous with those with which they are compared.

"For example, arsenic stands to antimony in the same numerical ratio as selenium to tellurium, within an extremely small fraction, so that by multiplying and dividing we have:—

$$\text{Arsenic } 75 \times \frac{\text{Tellurium } 64}{\text{Selenium } 40} = 120, \text{ Antimony} = 120.8.\text{"}$$

Our space does not allow further reference to the details of this paper than to give its conclusion, which is as follows:—

"It is not easy to fix the exact amount of importance which attaches to the numerical relations up to this time ascertained to exist between the atomic weights of the elements. Some are, no doubt, mere casual coincidences, and relations remarkably exact and symmetrical may exist between the atomic weights of bodies which have no analogies in their properties: for example, we may take calcium twenty, selenium forty, uranium sixty, bromine eighty, mercury one hundred. Here the differences are not only exact, but all the subsequent numbers are multiples of the first, and this between bodies remarkably dissimilar in their properties,—a striking proof of the necessity of caution in inferring relations of properties as following from relations of numbers. But, on the other hand, to reject the relations of number when accompanied by analogy of properties as unmeaning and unimportant, would be to err quite as much on the other side. When the received equivalent of an element, forming a term in a well marked series, differs from that obtained by calculation, it naturally leads, as Professor Mallet has remarked, to suspect an error and desire a redetermination. The fact that a group of elements, allied in their chemical characters, may be arranged in a series having a common difference or a definite ratio between its terms, confirms the propriety of grouping those elements together, and such analogies may, in doubtful cases, assist us in arriving at a correct classification."

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ORGANO-METALLIC RADICALS.

M. Cahours, in a recent number of the *Annales de Chimie*, publishes a most elaborate article on the above-named substances, from which we notice a few points of interest. The writer observes that there exists for simple bodies capable of union a point of saturation which exhibits an equilibrium that cannot be exceeded. So long as this state of equilibrium is not reached we can add to the first substance a new proportion of the second, until saturation is effected. Also, there are certain bodies which, when united to another, give products whose combining power is more energetic than that of the simple substance. Of these he enumerates oxide of carbon, sulphurous acid, etc., which not only are able to absorb fresh quantities of oxygen with greater facility than carbon and sulphur, but which are able to form with chlorine, iodine, etc., compounds corresponding to those of maximum oxygenization. These groups, which can be separated intact from their combinations, and which subsequently present all the appearances of simple bodies, are named *radicals*. Every compound may be regarded as a system of molecules in equilibrium, whose atoms are attracted by affinities more or less strong. If we replace one or several of these atoms by an equal number of some other substance, we obtain new compounds, which present the same mechanical grouping as the primitive product, and whose equilibrium will vary within any extended limits, according to the force of the attractions of the elements of the new substance. Thus ammonia can exchange all or part of its hydrogen for chlorine, bromine, iodine, carbon, ethyle, metals, etc., to form compounds belonging to the same system, but in variable states of equlibrium. Thus, while ammonia resists a dull red heat, chloride of nitrogen is destroyed at a temperature below that of boiling water. When methyle, ethyle, amyle, etc., unite with certain simple bodies, they engender products whose affinity for oxygen exceeds that of the simple substance. Thus zinc, whose behavior to water at ordinary temperatures is very quiet, decomposes it with violence when united with methyle or ethyle. The same occurs with magnesium and aluminium, and still more so with the most electro-positive metals, such as potassium and sodium. The most electro-negative metals, such as zinc, tin, lead, and mercury, which, like the preceding, can couple themselves with the alcoholic radicals, form, like them, compounds with a strong affinity for oxygen, chlorine, etc.; but these affinities are less energetic, and when the saturation point is obtained, they comport themselves as inert substances towards these bodies. The compounds of ethyle and methyle with metals, being able to separate themselves intact from new combinations, play the part of elementary substances. The curious properties of the metallic ethylides and methylides, which behave like real metals, more electro-positive than the simple metals which they contain, have created legitimate doubts as to the elementary character of the metals themselves. Ethyle and methyle unite with the electro-negative bodies which stand at the head of the series of simple bodies (oxygen, chlorine, etc.) and form stable and neutral compounds. As we descend the scale and approach potassium, which is at its base, we obtain less stable compounds invested with such energetic affinities for the substances higher in the scale, that a molecule is displaced, and simple and stable compounds produced. The remainder of the paper is occupied with descriptions of metallic compounds of ethyle and methyle.

NEW METALLIC ELEMENT.

Von Kobell has discovered in euxenite, æschynite, and samarskite, and a tantalite from Tammela, a new metallic acid, belonging to the same group with tantalic and niobic acids. To the new metal contained in this acid the author has given the name of *Dianium.*

ALUMINUM LEAF.

A Parisian gold-beater, Degousse, has succeeded in obtaining leaves of aluminum as thin as those from gold and silver. The aluminum must be reheated repeatedly over a chafing-dish during the process of beating. This leaf is less brilliant than that of silver, but it is not so easily tarnished as the latter. It is easily combustible, taking fire when held in the flame of a candle, and burning with an exceedingly intense white flame.

According to Fabian, the chemical lecturer will find aluminum leaf to be well adapted for exhibiting the characteristic properties of the metal. It dissolves, for example, with surprising rapidity in a solution of caustic alkali.

NEW METHOD OF PREPARING THE METAL CALCIUM.

Caron has succeeded in preparing large quantities of calcium by the following process: A mixture of 300 parts of fused and pulverized chloride of calcium, with 400 parts of granulated, distilled zinc, and 100 parts of sodium in pieces, is to be heated to redness in a crucible. The reaction is feeble, and after some time flames of zinc appear. The heat is then to be moderated, the temperature remaining as high as possible without volatilizing the zinc; after a quarter of an hour the crucible may be withdrawn from the fire. It contains a well-fused metallic mass, which is highly crystalline, and which contains from 10 to 15 per cent of calcium. The alloy is then to be placed in a crucible of gas-retort carbon, and the zinc expelled by heat. In this manner Caron obtained masses of 40 grammes at a single operation, and containing only the impurities of the zinc employed. As thus employed, calcium has a brass-yellow color, and a density of from 1.6 to 1.8. It is not sensibly volatile, but filings of the metal burn with red sparks of remarkable beauty, without formation of vapor, which seems to show that the metal is not volatile at the temperature of its combustion. The author promises to communicate the results of similar experiments in the preparation of barium, strontium, etc. — *Comptes Rendus.*

THE METALLURGY OF PLATINUM.

The metallurgy of platinum is altogether a modern art, the introduction of the metal into the laboratories of science and industry dating but from a few years back; and although particularly deserving of the attention of chemists, the metallurgy of platinum and its associated metals is, in general, but little known. Except for chemical purposes, platinum has not hitherto received any important application; but when we know better where to look for its ores, and when the deposits already known are more extensively worked, the ores of platinum will, perhaps, become no rarer than gold; and as the metal is almost indestructible, and as its value protects it from losses and accidents of all kinds, it must in time accumulate, and thus become

more plentiful. It may then, perhaps, be applied to other useful purposes in which its weight and slightly tarnished color will be no objection, or for which its absolute unalterability will give it a peculiar value. The solution of these questions, however, depends on the price for which the metal can be supplied; and the chemist is particularly interested in seeing its cost so far reduced that the large vessels of the laboratory may be made of platinum. It was in the hope of facilitating a progress of this kind, that MM. Deville and Debray, of France, undertook a series of difficult researches, costing four years of labor, the results of which have been recently given to the public in the *Annales de Chimie et Physique.*

Until the first communications of these chemists were published, no one dreamed of utilizing all the metals found with platinum, and with the exception of palladium and osmium, which there was always a motive for separating, platinum alone has been extracted from the ores, leaving a residue, which has accumulated in all the manufactories in Europe as well as in the Russian Mint.

The processes described by them are exclusively by the dry way, and by fusion at a very high temperature. They are given in different chapters, which treat of "the revivification of pure platinum," "the metallurgy of pure platinum," "the extraction from the rough ore of a triple alloy of platinum, rhodium, and iridium of a suitable and invariable composition;" and, lastly, the extraction, whether from the residues or from the osmide of iridium, of the utilizable metals, platinum, palladium, rhodium, and iridium.

The apparatus by means of which these French chemists have succeeded in melting platinum in considerable quantities and casting it into ingots, consists of a furnace of lime bound with iron wire. The fuel most often employed was common coal-gas, but hydrogen may be used, and when pure will give a greater heat. The combustion was fed with a current of oxygen.

In commerce, platinum is found which is almost free from iridium, but which still contains traces of osmium and a little silicium. MM. Deville and Debray have discovered that fusion in lime by means of an oxidizing flame refines it perfectly, osmic acid being disengaged, and the silicium becoming converted into silicate of lime, which melts into a colorless bead, and moves rapidly about on the surface of the metal until it reaches the edge, where it is absorbed by the sides of the furnace. Platinum so melted and refined is a metal as soft as copper; it is whiter than ordinary platinum, and does not possess the porosity which has hitherto been an obstacle to the manufacture of an impermeable platinum sheath.

Melted platinum still possesses the property of condensing gases at its surface, and of producing the phenomenon of a lamp without flame. Its density = 21.15, — less than the density of ordinary platinum which has been subjected in the working to a powerful hammering.

At a meeting of the French Academy, June 4th, 1860, MM. Deville and Debray exhibited (1.) Two ingots of platinum weighing together twenty-five kilogrammes, fused in the same fire and cast in an ingot mould of cast iron. The surface of the metal shows evidence of perfect fluidity and carries the impression of characters engraved on the surface of the mould.

(2.) A toothed wheel of platinum, cast in ordinary founders' sand, was also shown. This was cast in the mode common for cast iron, in a two-part flask, with a sprue and vent holes as usual.

The metal used was obtained from a quantity of crude platinum and platinum money placed at their disposal by the Russian Government.

Among other curious results arrived at by MM. Deville and Debray, we may mention the discovery of another condition of osmium, differing from that obtained by the method of Berzelius. In its new form, so far from being oxidizable at common temperatures, it may be heated to the fusing point of zinc without oxidizing or yielding odors of osmic acid. As prepared by the old method, it was spongy with a sp. g. of 7; by the new one its sp. g. is 21.3, or even 21.4. The experimenters could not succeed in fusing it. Palladium likewise behaves in a singular manner. "It is soluble in zinc, but does not combine with it; for when the alloy is treated with hydrochloric acid, only palladium remains. With tin it is otherwise. If palladium with six times its weight of tin be fused at a red heat, and the alloy when cold be treated with muriatic acid, a brilliant crystalline compound remains, having a composition of $Pd_3\ Sn_2$." With silver and copper it yields similar compounds.

MAGNUS ON THE PROPERTIES OF IRON IN POWDER.

Metallic iron in a state of very fine division has for some years been used in medical practice. It is thus obtained when the oxide of iron is reduced by hydrogen. When well prepared, this form of iron is so combustible as to take fire on exposure to air, burning with scintillation. A manufactory has lately been established in the Tyrol for making iron-powder of very considerable fineness, although the process is mechanical, consisting in using very fine files. Its therapeutic properties have not yet been decided. It does not burn spontaneously in air, although it is extremely combustible, as the following experiment by Magnus clearly demonstrates. Thus, when a burning body is approached to these Tyrolean filings they do not inflame unless they are previously suspended from the poles of a magnet. This experiment is easily repeated, and is interesting in a lecture. If a magnet be thus armed with these fine filings, and a flame applied, a combustion begins which spreads rapidly, and if the magnet is jarred a shower of burning particles fall through the air.

ALLOTROPIC CONDITION OF IRON.

M. Keshner has recently shown that by the prolonged boiling of a basic nitrate of iron its condition is changed, so that a precipitate obtained with sulphate of soda, and dried in a current of air upon porcelain, is insoluble in concentrated acids, but very soluble in water, the solution being turbid by reflected and clear by transmitted light. In this state the iron does not exhibit the customary reactions with ferrocyanides and sulphocyanides. He also found that light, as well as heat, was capable of producing this allotropic state of the iron salts.

KRUPP'S STEEL WORKS AT ESSEN, GERMANY.

The cast-steel manufactory of F. Krupp, of Essen, is the largest steel manufactory in the world. It is situated on the skirts of the town, in the midst of the coal mines, and covers, with its buildings and yards, a space sixteen hundred by eighteen hundred feet; fifteen large chimneys tower above it, and an incredible number of small ones are continually in use. A cloud of smoke hangs all the week over the vicinity, and only disappears with the quiet of Sunday. About fifteen hundred men are employed in the

various works, and one hundred and fifty tons of coal are consumed each day. The process employed for manufacturing the steel was discovered after many expensive and laborious experiments by Mr. Krupp, and is kept a profound secret, only a few trustworthy men being allowed to work in the room where the important mixtures are made. The method is said to be founded on the principle of melting together carbonized and decarbonized iron, cast and wrought-iron, and thus obtaining a mixture which has the known composition of steel.

I was told by a metallurgist at Horde that he had succeeded in obtaining steel in the same way (indeed, it is a process which has long been known to chemists); but all his attempts to make crucibles to stand the heat and action of the materials were unavailing. Others, again, declare that the art lies in the application of a peculiar kind of flux or glass, which protects the smelted metal and allows it to unite properly. Be the process what it may, the results are remarkable. England has sought to compete with this manufactory, but she has always failed. No country has even approached in the size of its production the massive pieces which are turned out here. A mass of ten thousand pounds of cast-steel was sent to the Paris exhibition. The largest shaft of the same material ever made here was, when turned, thirty feet long and ten inches in diameter, and is now in use on a French steamer, and cost six thousand dollars; and a single piece of steel has been produced weighing twenty thousand pounds.

Car axles of steel have been largely manufactured, and Mr. Krupp binds himself to pay a penalty of ten thousand five hundred dollars if any that he sells break within ten years, which, I may say, is throwing the responsibility for this species of railroad accidents upon the right shoulders. Railroad car wheels and bells are sometimes made from steel, but the chief manufacture at present is cannon. These are made from the smallest size up to sixty-eight-pounders, and are cast in a single piece and afterwards bored out. The construction of these guns is remarkable; they consist of a thick, solid cylinder of steel, made precisely half the thickness of the cast-iron guns (this proportion is assumed arbitrarily, since no experiments have been instituted to prove the proper proportions which should be adopted with this new material), but the metal mass is not heavy enough to withstand the recoil of the powder and ball, and, consequently, a heavy shell of cast-iron surrounds the breech. The excellence of the guns as warlike instruments is everywhere acknowledged.—*Correspondence of the United States Railroad Journal.*

ON TUNGSTEN STEEL.

It is stated that cast-iron containing from five to six per cent of tungsten acquires an extraordinary hardness. Cast-steel also, containing from four to five per cent of tungsten, will have a tenacity and quality superior to those of the best steels, and will become capable of taking a most extraordinary temper and hardness. According to trials made at Neustadt, tools of tempered tungsten steel were capable of cutting objects made of ordinary cast-steel equally tempered.

Tungsten has nearly the same specific gravity as gold, and this density is recognizable in the cast-steel alloyed with it, by the alteration in the grain of the fractured surface, and by the heightened ring of the steel. In hardness, metallic tungsten nearly approaches the hardest of natural bodies, and it communicates this property to cast-steel, without injuring its tenacity and

malleability when the addition is of 2.5 per cent. The absolute solidity of tungsten steel exceeds that of all other known steels; for fifteen consecutive experiments with a machine in the Polytechnic Institute of Vienna showed the highest power of resistance to be 1,393 hundredweight, and the lowest 1,015 hundredweight, giving an average of 1,158 hundredweight to the square inch; so that this steel exceeds all other kinds hitherto subjected to experiment.

For the preparation of this steel wolfram (tunsgtate of iron and manganese) is purified by roasting, pulverizing, and washing, and by a final treatment with dilute hydrochloric acid. The purified ore is then placed in a crucible with coal dust, and heated to redness for three hours. The ore is reduced, and a porous gray mass is obtained, formed of metallic tungsten alloyed with carburets of iron and manganese. This is the product which is used for the preparation of tungsten steel, and it is thrown into the crucibles in which cast-steel is melted. Care must be taken before running the steel into ingots to increase the heat of the fire, for ten or twenty minutes, so as to carry the temperature of the crucible to a bright redness. It appears, however, that the manufacture of tungsten steel in quantity yet presents considerable difficulties, and that it has not yet been practicable to prepare masses or bars of considerable size which are free from faults.

It is desirable that this application of tungsten should be practically established, for this would render a great service to mining industry, by utilizing a material of wide distribution, which until now has been banished from the list of ores capable of profitable exploration.

The only applications of the compounds of tungsten hitherto made, and which have not had great success, owing perhaps to the qualities of the products not being sufficiently remarkable or superior to give much value, or, possibly, because the processes and preparations were too costly, are the following: use of tungstic acid for coloring yellow; oxide of tungsten for coloring blue; and the employment of tungstate of soda in dyeing and calico printing, and as a substitute for stanniate of soda.

INFLUENCE OF THE PRESENCE OF TITANIUM ON THE QUALITY OF IRON.

Mr. David Mushet, the well-known English iron manufacturer, in a communication to the London *Engineer Journal*, expresses an opinion, that the mystery of the excellence of the Danemora and other irons is due to the presence in the iron of a small proportion of the metal titanium. Some time ago, his attention having been drawn to this matter, by the fact that crystals of titanium occur in the hearths of Norwegian blast furnaces, he instituted a series of experiments, which he describes as follows: —

By alloying small quantities of titanium with iron and steel I obtained surprising results, which at once convinced me that I was upon the right track at last. I now had the iron ores of the districts I have named carefully examined for titanium, and I found that all of them contained titanic acid, and that whichever ore most abounded in titanic acid, the iron and steel produced from that ore was the most celebrated and valuable. In reducing likewise the ores of iron and titanium I found that a peculiar slag, or scoria, was always obtained, and of such a remarkable character that it was impossible, when once seen, ever to mistake it for any other kind of iron slag; and from the color and appearance of this slag I could at length, by experience,

determine with tolerable accuracy the percentage of titanium, and therefore of titanic acid, in any given specimen of titanium ore or titaniferous iron ore. And now the whole mystery of the Danemora iron was at once elucidated; and its explanation is this,—the magnetic iron ore from which the Danemora iron is prepared contains a larger percentage of titanic acid than other ores from which the inferior brands of Swedish iron are obtained, and the bar iron obtained is therefore more largely alloyed with titanium.

Moreover, as titanium is perhaps the most difficult to fuse of all the metals, its alloy with bar iron requires a higher temperature for its fusion than that required for the fusion of bar iron destitute of such an alloy, and it is well known that the best Danemora iron, in the state of iron, is more difficult to melt than any other charcoal bar iron. It has also been observed by the steel trade that steel irons which require much melting, *i. e.*, which are difficult to melt, yield cast steel possessing great body, *i. e.*, powers of endurance when made into a tool.

It will, I am aware, be objected that chemists have as yet detected no titanium in these irons. I grant this; and I will explain why it has been so. Chemists confound the titanic and silicic acids one with the other, and, besides this, the insoluble residuum is likewise a form or compound of titanium. I will cite a case in point which completely confirms and proves my position. An extraordinary magnetic iron-sand was brought to England from a volcanic district in the South Seas. Some of this ore was sent to me, and I perceived at once that it was an ore of titanium. On testing it by my processes, I found that it must contain at least eight or ten per cent of titanic acid.

I have from this ore manufactured steel of surpassing excellence; samples of which are in the hands of the fortunate owner of the deposit, the value of which for steel and iron making is incalculable. The analogy between this ore and that of Danemora has already been observed by parties acquainted with the manufacture of Swedish iron; but the explanation of the similarity was reserved for me to give. Until my discoveries upon this subject, titanium has only been alluded to as a pernicious ingredient in iron ores or iron, causing redshortness, etc. One chemist alone has remarked that titanium in small quantities does not appear to affect the quality of iron injuriously; and this remark I find in an almost obsolete French work on chemistry. The celebrated Damascus blades are made from iron reduced from a highly titaniferous iron ore. The Wootz ore of India is more titaniferous than that of Danemora. The Elba iron ore is moderately titaniferous, and so also is the Brush iron ore of the Forest of Dean. Iron alloyed with titanium possesses a degree of body and durability unknown in ordinary bar iron of good quality. First-rate steel can only be made from iron containing titanium. There is a spurious, ductile, and easily workable steel which owes its usefulness to the presence of manganese; but between which and the titanic steel there exists as wide a difference, in point of excellence, as there is between common hot-blast Scotch pig iron and the best Shropshire or Blaenavon cold-blast iron.

This difference is well known to the Sheffield trade. Titanium steel has body. Manganese steel has little or none; but it is ductile, and hardens well, and is cheap besides, and can be applied to inferior purposes. Not that the Sheffield steel-makers ever dreamed about titanium; but what they call body is, in intelligible language, rendered correctly by the term titanium; and to the fact of this metal existing in alloy with Danemora and other Swedish bar

irons, to the extent of from one quarter per cent to about one or one and a half per cent, is mainly due the rise, progress, and present prosperity of Sheffield and its manufacturers.

When pure gray cast iron is alloyed with titanium in certain proportions, it may, when cast into ingots, be drawn into bars of great strength and tenacity. I have thus drawn an ingot of gray cast iron three inches square into bars three-quarters inch square, and perfectly sound.

The specific gravity of titanium has been most erroneously assigned by chemists as 5.3. It is in reality a metal somewhat heavier than iron, and that steel which contains a large alloy of titanium is consequently found to have a higher specific gravity than other steel. It may be objected that small proportions of titanium, in alloy with iron, cannot produce a marked effect. To this I reply, that with one-half per cent of carbon, and under that proportion, are produced nearly all the marketable varieties of bar iron and steel with which we are familiar; and it is also certain that one-half per cent of phosphorus renders bar iron crystalline, and one-half per cent of sulphur occasions redshortness; therefore, that so small a quantity as one-half per cent of titanium should constitute the excellence of steel iron is not at all an anomaly. Magnetic iron ores always contain some titanic acid, and such is its efficacy in improving the quality of iron, that the most impure magnetic ores, abounding with pyrites, nevertheless yield iron of a superior class. If the iron used in the manufacture of rails was prepared from pig-iron, smelted from ordinary iron ores, with the addition of a tenth part of titanium, or even one-twentieth, the rails thus manufactured would be at the least four times more durable than they are found to be under the present process of manufacture. This is only one of the many important results which the discovery of the effects of an alloy of titanium upon iron will lead to. The deposit of titanium ore of the iserine variety, to which I have alluded, extends twenty miles in length by half a mile in breadth, and has no bottom at four yards in depth. It is all of one uniform quality, in the state of iron-sand, so minutely divided, that of half a ton which I have had, the whole of it readily passes through the meshes of a sieve of three thousand six hundred holes to the square inch, that is to say, the largest grains are not so much as one thirty-six hundredth part of an inch in diameter. From my experiments with iserine heated and immersed in water, I am of opinion that the whole of this extraordinary deposit of iron-sand has been, when at an intense temperature, suddenly quenched in water. It probably existed in the interior of a volcano, into which at some epoch an irruption of the sea has taken place, and the sand has been thrown out by the force of the explosion which must have ensued. The region is volcanic, and there are lofty extinct volcanoes near the locality of the deposit.

Reckoning thirty hundredweight per cubic yard as the weight of this sand, the number of tons in the area already ascertained of this deposit will amount to one hundred and eighty-five millions eight hundred and fifty-six thousand tons, a quantity sufficient to furnish a supply for all the furnaces in England with ore for twenty-five years.

IMPROVEMENTS IN THE MANUFACTURE OF IRON.

It is well known that articles of cast iron may be rendered malleable in a degree, by closely packing them in powdered hematite (peroxide of iron) in tight fire-brick cases, and subjecting them to a red heat, in an annealing

furnace, for a period of time varying from six to ten days, finally allowing them to cool slowly. In this case, the character of the iron is changed, by a removal of a part of its carbon, through the agency of the oxygen of the powdered hematite. An improvement on this process, recently devised by Prof. A. K. Eaton, consists in the substitution of the oxide of a volatile metal, as zinc, instead of that of iron; the volatile metal going off in vapor as it parts with its oxygen to the carbon of the iron, and thus affording room for fresh portions of oxide to fall in and continue the process. The metallic vapor is at the same time received in a condensing vessel, and is afterward cast into ingots.

According to the New York *Tribune*, the same inventor has devised a similar method applicable to the production of steel, which, indeed, may be produced in the process described; steel being, in fact, but a partially decarbonized cast iron, and, therefore, actually resulting in one stage of the conversion of cast into malleable iron.

Prof. Eaton, however (according to the above authority), has found that the hydrates and carbonates of the alkalies, heated in contact with cast iron, exert a decarbonizing action like that of oxide of zinc. Selecting carbonate of soda, a compound of carbonic acid and oxide of sodium, and causing this to fuse and cover bits of cast iron, the salt is decomposed, the oxide of sodium giving up its oxygen, which unites with the carbon of the iron, forming carbonic oxide, which escapes, together with the carbonic acid of the salt. Metallic sodium is vaporized in meeting the oxygen of the air, admitted in limited quantity into the retort for this purpose, and is reconverted into soda. The liquid solution reaches every portion of the surface of the cast iron, and the chemical action gradually penetrates the whole mass. The affinity of the sodium for sulphur and phosphorus causes them to be seized and withdrawn from the iron, and they both are retained by the alkali in the condition of sulphuret and phosphuret of sodium. At the same time silicon is also separated, through its affinity for oxygen, with which it forms silicic acid, and this unites with the soda, forming silicate of soda. The experiments so far made are highly encouraging, that this will prove not only an efficient method in practical operations upon a large scale of removing these elements so injurious to iron, but that, in consequence of this property, the vast bodies of sulphurous iron ores, which, though rich in metal, have so far defied the skill of metallurgists to effect with economy their reduction to good iron, may now be rendered of practical importance. The experiments have been made upon a scale which might answer for manufacturing operations; a product of several hundred pounds of steel having been obtained, which has been cast into ingots, hammered into bars, and made into a variety of small articles.

The expense of the manufacture is comparatively light. In the first place, the raw material employed is the cheap cast iron, which never before was considered applicable to this use. The process is rapid, and no excessive heat is required, like that for melting and carbonizing malleable iron, as practised in one method of making steel, — a method which involves the use and rapid consumption of highly expensive crucibles. A red heat sufficient to fuse the soda is all that is necessary. Crude carbonate of soda, or soda ash, suitable for this use, is a cheap product, especially considering that the same bath of it can be used repeatedly, and when it becomes too impure, it can be restored by inexpensive methods to its former condition; though some more useful application for the metallic sodium may render this inex-

pedient. The apparatus is a cast iron retort of convenient form, made, it may be, to be set upright and to be charged at the top, or to lie horizontally, like the retorts of the gas-houses, in which case the charging door would be in the front, a sloping entrance leading down into the upper portion of the retort. The articles to be converted into steel are placed one upon another in this vessel, and sufficient soda is introduced to flow over and cover them as it melts. It is not necessary that the articles should be kept immersed in the liquid soda, the most satisfactory results having been obtained even when a considerable portion of the soda, after once covering the bars, had been allowed to escape. The retort itself becomes decarbonized,— converted into steel, and finally into malleable iron. In this condition it may continue in use for many firings; and considering the low heat employed, there is little doubt it can be made almost permanent.—*N. Y. Tribune.*

MELTING ZINC BY MEANS OF GAS.

A report has been made to the Society for the encouragement of National Industry (France) upon the method of melting zinc by means of ordinary illuminating gas, proposed by M. Miroy. The results are interesting to zinc-founders, type-founders, and those engaged in melting and casting tin, lead, or the fusible alloys of these metals. We translate the following from the report: —

The melting of zinc, which is generally made in crucibles of plumbago, and in a coke or coal fire, involves a very elevated temperature, difficult to regulate, and a consequent loss of metal by volatilization and combustion. The metal also acquires bad qualities, which workmen attribute to its being burned or scorched, but which appear to be due to the mechanical penetration of the oxide of zinc into the pores of the metallic mass. The melted metal then presents a pasty consistence, and the action of the chisel and the file becomes more difficult upon the casting, owing to the alteration of the malleability.

To remedy these disadvantages, M. Miroy fuses zinc by gas. His apparatus consists of a crucible of cast iron, which may contain thirty to thirty-five kilogrammes of zinc. This is placed in a cylindrical furnace of conical form, where it is exposed to the combustion of ordinary illuminating gas, which enters obliquely on two sides by two tuyeres. These are each concentric with larger tuyeres, through which air is forced by means of a blower driven by the machinery of the establishment. The interior diameter of the smaller, or gas tuyère, is eighteen millimetres; those of the air, seven centimetres. The volume of air used has not been determined, but is estimated to be to that of the gas as three to one. The inventor thinks that by this method zinc may be melted more rapidly and cheaply than by coke, while the heat may be so regulated as not to injure the metal. There is also a great saving in the cost of crucibles. — *Répertoire de Chimie.*

ON THE EMPLOYMENT OF THE METAL MAGNESIUM AS AN ILLUMINATING AGENT.

It has recently been proposed by M. Bunsen, of Paris, to employ the metal magnesium for producing light by its combustion. This metal, it is well known, is the base of magnesia, as aluminum is of alumina. It is, however, much less known than the latter, although it is but a short time since both

were regarded as alike obscure and useless. Aluminum is remarkable for its lightness, being only about one-fourth the weight of silver; but magnesium weighs only about two-thirds as much as aluminum, its specific gravity being only 1.74. It is of a silvery whiteness, undergoes no change in dry air, and is subject to but slow oxidation in a damp atmosphere, and that only quite superficially; it may be hammered, filed, and drawn into threads. It is prepared by decomposing the chloride of the metal at a red heat, in a close crucible, by means of potassium or sodium. The metal takes fire at the temperature at which bottle-glass melts, and burns with a quiet and excessively vivid light.

The intensity of the light thus produced, as determined by Bunsen, is only 525 times less than that of the sun. Compared with an ordinary candle, it appeared that a wire of magnesium 0.297 millimetre [1 mm. = 0.0394 inch] in diameter produced as much light in burning as seventy-four stearine candles, five to the pound. In order to support this light during one minute a piece of wire 0.987 metres long, weighing 0.1204 gram [1 gram = 15.4325 grains], was required.

Only 72.2 grams of magnesium, therefore, would be needed, in order to maintain during ten hours an amount of light equal to that of seventy-four stearine candles, consuming about 10.000 grams of stearine.

According to Bunsen, magnesium wire is readily obtained by forcibly pressing the metal through a hot steel die by means of a steel piston. Bunsen's arrangement for burning the wire was made by connecting spools of it with rollers moved by clock-work, so that the wire should be unrolled like the ribbon of paper in Morse's telegraph. The end of the wire, thus gradually pushed forward, passed into the flame of an ordinary alcohol lamp, where it took fire.

It is evident that a magnesium lamp of this sort must be much simpler and more compendious than any of the existing arrangements of the electrical or of Drummond's light; for light-houses, etc., where an intensely brilliant illumination is required, it can hardly fail to rival either of these. Where an extraordinary amount of light is needed, it could readily be produced by burning large wires, or several thin ones at the same time. Another important consideration is the fact that the spools of wire, as well as the clock-work and spirit-lamp, are easily transportable.

It is not, however, to the intensity alone of the magnesium flame that these lamps owe their utility, for the photo-chemical (*i. e.*, photographical) effect of the light is also very great; according to Bunsen, the photo-chemical power of the sun being only 36.6 times greater than that of the magnesium flame. The latter must therefore be useful in photographing by night, or in any dark or subterranean locality; the evenness and remarkable tranquillity of the flame especially commending it for this purpose.

The present high price of magnesium, it is true, must prevent any extended use of it for technical purposes. For example, Lenoir, of Vienna, charges 3 florins [1 Fl. = 51 cents] for a gram of it; hence the cost per minute of the light just described would be 36 *Neukreutzer* [1 ktr. = about five-sixths of a cent], and the cost during ten hours would amount to 216 florins, while the ten kilogrammes of stearine could be procured for less than 14 florins. But, even at this price, it could still be used by photographers, since it would only be required for exceedingly short intervals of time, and all unnecessary consumption of the wire might be prevented by stopping the clock-work.

NEW FUSIBLE METAL.

Dr. B. Wood, of Nashville, Tenn., has recently secured a patent for a new fusible alloy, — composed of cadmium, tin, lead, and bismuth, — which fuses at a temperature between 150° and 160° Fahrenheit. The constituents of this fusible metal may be varied according to the other desired qualities of the alloy, viz.: cadmium, one to two parts; bismuth, seven to eight parts; tin, two parts; lead, four parts. It is recommended as being especially adapted for all light castings requiring a more fusible material than Rose's or Newton's "fusible metal," it having the advantage of fusing at more than 40° Fahrenheit lower temperature than these alloys; and, owing to this property, may replace many castings heretofore made only with amalgams.

In a communication to the *U. S. Mining Journal*, Dr. Wood says: —

The advantage of possessing the joint qualities of great fusibility, malleability, strength, etc., in a metal designed for use as above, is too evident to dwell upon.

One of the most useful of this class is the alloy commonly called "fine solder," consisting of one part of lead and two parts tin. It is perfectly malleable, highly tenacious, and melts, according to Professor Graham, at the temperature of 360° Fahrenheit, being the most fusible of any of the mixtures of lead and tin. But its melting point is too high for a solder for the more fusible tin-metals, such as the ordinary pewter and Britannia-ware, etc. Another objection is its softness.

The alloys consisting of lead, tin, and bismuth, commonly called "bismuth solders," are harder and more fusible, but they are proportionably brittle. A common formula for very easily melted solder is, sixteen parts tin, eight lead, four bismuth. A more fusible mixture and the most fusible *alloy* hitherto known is that discovered by Sir Isaac Newton, consisting of three parts tin, five lead, eight bismuth. This melts, according to Professor Graham, at 202° Fahrenheit. No practical improvement has ever been made upon this by any combination of the constituents, although certain combinations possess, according to some experimenters, a lower melting point by one or two degrees, — a difference too slight for appreciation by ordinary tests. Practically, the melting point is somewhat higher, requiring a temperature of about 210° for perfect liquefaction. In view of its remarkable fusibility this alloy has received the distinguishing name of "fusible metal." It is too brittle for ordinary use as a solder, but is much employed for casting, and in making dies for light work, and for taking impressions from medallions and other objects. Melting below the temperature of boiling water, it may be used upon the fresh plaster cast, or other moist surface. But it has the disadvantage that when used at a heat barely sufficient for fusion, it is not fluid enough to take the sharp outlines, and congeals before it can flow into the interstices; while a small additional heat raises its temperature above that at which water boils, whence steam is produced, which spoils the work.

The melting point of these alloys may, as is well known, be lowered to any extent by the addition of mercury; but this metal, even in small proportions, renders them so frail and brittle as to be worthless for the ordinary uses. It also causes them to tarnish, and is partly eliminated from the compound, being retained rather as a foreign admixture than as a chemical constituent, whence it occurs that these amalgams injure other metals with

which they come in contact. So, also, when used for anatomical injections, the mercury permeates and blackens the tissues.

My improvement greatly obviates these defects, and meets more perfectly the requirements of alloys of this class. The composition composed of cadmium, lead, and tin, melts somewhat under 300° Fahrenheit, or 60 or 70 degrees below the melting point of the "fine solder" above referred to. It is equal to it in malleability and tenacity, is much harder and stronger, and admits of a higher polish. It ranks in fusibility with the more easily melted "bismuth solders," and is believed to be greatly superior to any of them in all the other requisites for this purpose. The advantages for other purposes of a metal possessing these qualities will readily suggest themselves.

The composition consisting of cadmium, lead, and tin, in conjunction with bismuth, melts between 150° and 160° Fahrenheit, being some 50° or 60° below the melting point of Newton's "fusible metal," mentioned above, corresponding very nearly with it in respect to malleability and tenacity, but being harder and more adhesive. It is adapted to similar purposes; and the low temperature at which it fuses renders it applicable in many cases where the other would not answer, while it is free from the objections appertaining to the amalgams resorted to in such cases. As a material for anatomical injections it will be found superior in every respect, it is believed, to the amalgams in use.

ON THE PROPERTIES OF CADMIUM.

In a communication on the above subject to the editors of *Silliman's Journal*, by Dr. Wood, of Nashville, Tennessee, the inventor of the new fusible alloy, he says: —

The remarkable degree in which cadmium promotes the fusibility of combinations of lead and tin is especially worthy of note. The alloy of one to two parts *cadmium*, two parts lead, and four parts tin, is considerably more fusible than an alloy of one or two parts *bismuth*, two parts lead, and four parts tin; and when the lead and tin are in larger proportion, the effect is still more marked. It takes less cadmium to reduce the melting point a certain number of degrees than it requires of bismuth, besides that the former does not impair the tenacity and malleability of the alloy, but increases its hardness and general strength. Bismuth has always held a preëminent rank among metals as a fluidifying agent in alloys. Its remarkable property of "promoting fusibility" is specially noted in all our works on chemistry. But I do not find it intimated in any that cadmium ever manifests a similar property. The fact, indeed, appears to have been wholly overlooked, owing perhaps to the circumstance that as an alloy with certain metals cadmium does not promote fusibility.

Cadmium promotes the fusibility of some metals, as copper, tin, lead, bismuth; while it does not promote the fusibility of others, as silver, antimony, mercury, etc. (*i. e.*, does not lower the melting point beyond the mean). Its alloy with lead and tin in any proportion, and with silver and mercury within a certain limit, say, equal parts, and especially if two parts silver and one of cadmium, or two parts cadmium and one mercury, are used, are tenacious and malleable; while its alloys with some malleable metals (gold, copper, platinum, etc.), and probably with all brittle metals, are brittle.

BORACIC ACID IN THE SEA-WATER OF THE PACIFIC.

At a recent meeting of the California Academy of Natural Sciences, the following paper on the above subject was read by Dr. John A. Veatch, of San Francisco: —

The existence of boracic acid in the sea-water off the California coast was brought to my notice in July, 1857. I had, in the month of January of the previous year, discovered borate of soda and other borates in solution in the water of a mineral spring in Tehama county, near the upper end of the Sacramento valley. Prosecuting the research, I found traces of boracic acid, in the form of borates, in nearly all the mineral springs with which the State of California abounds. This was especially the case in the coast mountains. Borate of soda was so abundant in one particular locality, that enormous crystals of that salt were formed at the bottom of a shallow lake, or rather marsh, one or two hundred acres in extent. The crystals were hexahedral, with beveled or replaced edges and truncated angles; attaining the size, in some cases, of four inches in length by two in diameter, forming splendid and attractive specimens. In the same neighborhood, a cluster of small thermal springs were observed holding free boracic acid in solution. A few hundred yards from these, a great number of hot springs, of a temperature of two hundred and twelve degrees Fahrenheit, rose up through the fissures of a silicious rock. These springs held a considerable quantity of borax, as well as free boracic acid. Many other localities furnished similar indications, but in a less extensive form.

In progress of the examination, I found that the common salt (chloride of sodium) exposed for sale in the San Francisco market, and which, it was understood, came from certain deposits of that article on the sea-margin in the sourthern part of the state, also furnished boracic acid. I was led to attribute it to the fact of mineral springs emptying into the lagoons furnishing the salt. It was, therefore, a matter of no small surprise, when, on a visit to the localities, I found no trace of acid in any of the springs in the adjacent district. This led to an examination of the sea-water, and a detection of an appreciable quantity of boracic acid therein. It was at Santa Barbara where I first detected it, and subsequently at various points, from San Diego to the Straits of Fuca. It seems to be in the form of borate of soda, and perhaps of lime. The quantity diminishes towards the north. It is barely perceptible in specimens of water brought from beyond Oregon, and seems to reach its maximum near San Diego.

This peculiarity seems to extend no great distance seaward. Water taken thirty or forty miles west from San Francisco gave no trace of acid. In twelve specimens, taken at various points betwixt this port and the Sandwich Islands, only that nearest our coast gave boracic acid. In ten specimens taken up in a trip of one of the Pacific mail steamers from Panama to San Francisco, no acid was observed south of the Cortez Shoals.

I have not as yet been able to obtain specimens of water south of San Diego, nearer the shore than the usual route of the mail steamers. Neither have I been able to test the breadth of this boracic acid belt any further than the fact above stated, of no acid being found at the distance of thirty or forty miles west from the Golden Gate. I think it probable that it is confined within the submarine ridge running parallel with the coast, the southern portion of which is indicated by certain shoals and island groups. The source of the acid is undoubtedly volcanic, and the seat of the volcanic

action is most likely to exist in this submerged mountain range. It strengthens the probability of the eruptive character of the Cortez Shoals.

INFLUENCE OF ARSENIOUS ACID UPON THE WASTE OF THE ANIMAL TISSUE.

According to experiments made by Prof. Schmidt and Dr. Stuerzwage, of Dorpat, arsenious acid, when introduced into the circulation, occasions a considerable diminution of the ordinary waste of the tissues.

This decrease, which amounts to from twenty to forty per cent, occurs even after the administration of very small doses; more rapidly if the acid is injected directly into the veins; more slowly, yet with equal intensity, if absorbed from the intestines. The action is most striking in the case of fowls, which neither vomit after injection of the arsenic nor reject their accustomed food; but even in cats, which are subject to vomiting after the injection, and must therefore be regarded as in a starving condition, the waste of the organism was diminished about twenty per cent, after subtracting the decrease occasioned by the mere want of food.

This fact satisfactorily explains the fattening of horses after small doses of arsenious acid, a phenomenon well known to horse-dealers.

An amount of fat and albuminous substances equivalent to the repressed carbonic acid and urea remains in the body and increases its weight, if the animal receives at the same time a sufficient amount of food.

When larger doses of arsenious acid are given, nervous symptoms appear, which may be classified in two groups: spinal irritation and paralysis. To the first may be referred the vomiting, the accelerated respiration, the feeble pulse; to the last, the inclination to sleep, the weakness, and the retarded and labored breathing. Both may be explained by the very considerable congestion of the central organs which was constantly observed in post-mortem examinations.

These experiments are of particular interest, since they go far to prove the complete reliability of the published accounts of the custom of "arsenic-eating," which is said to prevail among the peasantry of several Austrian provinces. These accounts have been time and again held up to ridicule by toxicologists, and, as a rule, have been received with suspicion by all scientific men.

During the past year, a great amount of evidence bearing on this subject has been collected by Prof. Heisch, F. R. C., and published in the London *Chemical News* (May 19, 1860); so that if human testimony is worth anything, the fact of the existence of arsenic-eaters must be regarded as beyond a doubt. Prof. Heisch states that he has been informed by Dr. Lorenz, Imperial Professor of Natural History, formerly of Salzburg, that he knows that arsenic is commonly taken by the peasants in Styria, the Tyrol, and the Salzkammergut, principally by huntsmen and wood-cutters, to improve their wind and prevent fatigue. He gives the following particulars: —

The arsenic is taken pure in some warm liquid, as coffee, fasting, beginning with a bit the size of a pin's head, and increasing to that of a pea. The complexion and general appearance are much improved, and the parties using it seldom look so old as they really are; but he has never heard of any case in which it was used to improve personal beauty, though he cannot say that it never is so used. The first dose is always followed by slight symptoms of poisoning, such as burning pain in the stomach and sickness,

but not very severe. Once begun, it can only be left off by very gradually diminishing the daily dose, as a sudden cessation causes sickness, burning pains in the stomach, and other symptoms of poisoning, very speedily followed by death. As a rule, arsenic-eaters are very long lived, and are peculiarly exempt from infectious diseases, fevers, etc.; but, unless they gradually give up the practice, invariably die suddenly at last. In some arsenic works near Salzburg with which he is acquainted, he says the only men who can stand the work for any time are those who swallow daily doses of arsenic, the fumes, etc., soon killing the others.

Prof. E. Kopp has also stated (*Comptes Rendus*, 1856), that he found in the course of a series of experiments upon arsenic acid, — which was manufactured upon a great scale, and largely employed in calico printing by him, — that the weight of the body rapidly increased, some twenty pounds having been gained in the course of the two months during which he was subject to absorb the acid, his hands having been frequently in contact with the arsenical solution: arsenic being detected the while in his solid and liquid excrements. As soon, however, as the exposure to the arsenic ceased, his weight began to decrease, and in nine or ten weeks fell back to its normal, — one hundred and fifty pounds. It is reasonable, therefore, that direct, positive evidence like this, — though the instance be solitary, — where the subject of the experiment was a healthy, vigorous man, and a trained observer, ought to outweigh almost any amount of negative testimony, such as has been brought forward by physicians who have not witnessed similar effects upon their *diseased* patients, when the latter were treated with arsenical preparations. Another fact, says Prof. Heisch, mentioned to me by some friends, is well worthy of note. They say: "In this part of the world, when a graveyard is full, it is shut up for about twelve years, when all the graves which are not private property by purchase are dug up, the bones collected in the charnel house, the ground ploughed over, and burying begins again. On these occasions, the bodies of arsenic-eaters are found almost unchanged, and recognizable by their friends. Many people suppose that the finding of their bodies is the origin of the story of the vampire." In the *Medicinisches Jahrbuch des Oster: Kaiserstautes*, 1822, *neuest Folge*, there is a report by Professor Schallgruber, of the Imperial Lyceum at Grätz, of an investigation undertaken by order of government into various cases of poisoning by arsenic. After giving details of six *post-mortem* examinations, he says: "The reason of the frequency of these sad cases appears to me to be the familiarity with arsenic which exists in our country, particularly the higher parts. There is hardly a district in Upper Styria where you will not find arsenic in at least one house, under the name of hydrach. They use it for the complaints of domestic animals, to kill vermin, and as a stomachic to excite an appetite. I saw one peasant show another, on the point of a knife, how much arsenic he took daily, without which, he said, he could not live; the quantity I should estimate at two grains."

In this connection it must not be forgotten that, in the opinion of many scientific men, the healing action of various mineral waters may depend, in part at least, upon the arsenic which these springs are known to contain: a doctrine which is publicly taught by several of the chemical professors at Paris.

F. H. Storer, Esq., in a recent communication to *Silliman's Journal* on this subject, says:—

Taken as a whole, the medical evidence which has fallen under our

notice is adverse to the possibility of "arsenic-eating," only in so far as relates to the large quantities of the poison which, as is affirmed, the human body can accustom itself by long-continued habit to support with impunity. This last inquiry, however interesting in itself, is one on which very little is known with certainty as yet, and is plainly of quite secondary importance, in a scientific point of view, to that of the beneficial action of moderate doses of arsenious acid, which would now appear to be proved. — *Chemical News, et Silliman's Journal* (*F. H. Storer*).

Arsenic in England. — Recent English journals give the following account of the existence of arsenic in a brook or stream that gives name to the village of Whitbeck, in the county of Westmoreland. This brook rises among the mountains of Cumberland, and probably derives the arsenic which has been found in its waters from veins of arsenical cobalt ore, through which its waters percolate; for a few yards above the sources of the stream is the entrance of a mine, which yields this arsenical ore in abundance. So marked is the character of the Whitbeck water, that fish are never found in it, and ducks, if confined to it, soon perish; and yet it is habitually used for every purpose by the inhabitants of Whitbeck, and with beneficial effects so apparent that one might be justified in paradoxically characterizing arsenic as a very wholesome poison. The deadly element in dilution is productive of the most sanitary effects, as among the Styrian arsenic-eaters; and the villagers generally live to enjoy a healthy and robust old age, their lives extending much beyond the average in surrounding towns. The traveller is struck by the handsome features and rosy checks of the children. In the case of some laborers sent to work upon a railroad in the vicinity, the water at first produced the usual soreness of mouth, but after this had passed away their health was extremely good. The only effect it produces on horses is visible in the remarkable sleekness of their coats.

Arsenic in Articles of Domestic Use. — In the July number of the *American Medical Journal* Mr. M. Carey Lea calls attention to the great extension which the use of arsenical pigments has obtained in manufactures intended for household use. He shows that the greater part of green wall-papers, green borders, and green window-shades, are colored with Scheele's green or Schweinfurth green, both preparations of arsenic: in the former being the arsenite, and the latter the aceto-arsenite of copper.

Two specimens of wall-paper, one of border and three of window-shade material (all that he submitted to examination), were found to be colored with these pigments. He cites numerous instances where these materials have proved prejudicial to the health of those who inhabited the rooms in which they were contained.

It is a common idea that the quantity of this substance used in coloring is so small that its poisonous character is unimportant. This is a grave error. Mr. Lea obtained, by precipitating with nitrate of silver, from two square inches of material prepared for window-shades, no less than six grains of the yellow compound of arsenious acid with silver. If we suppose this to be the salt $3AgO, AsO_3$ described by Filhol, — it corresponds to a quantity of white arsenic (arsenious acid), which, in an ordinary window-shade, three feet by eight, would amount to no less than one-third of an avoirdupois pound! When a room is papered with paper colored with arsenic, it is safe to say that *many pounds* of this deleterious substance are spread over the walls.

Those who are not familiar with chemical pursuits, and who may wish to test specimens of green material for themselves, may easily do so in the following manner. A piece of the size of the top of a tumbler is taken, placed in a glass, covered with strong ammonia, and left to stand for a few hours. As the green arsenical pigments always contain copper, which imparts a blue color to ammonia, the absence of such a coloration may be taken as a probable proof of the absence of Scheele's or Schweinfurth green. If the blue coloration makes itself evident, the liquid is to be poured carefully off, so as to be quite clear, and a fragment of lunar caustic, previously wiped perfectly clean with a wet cloth, is to be dropped into it. If the caustic turns yellow, and diffuses a slight yellow cloudiness, either permanent or soon disappearing, arsenic is present.

M. Chevallier has recently published a book devoted expressly to this subject, the extension of which has attracted much attention, particularly since arsenical dyes have been used for material for ladies' dresses, and his work has been already translated into German. It is asserted that the French government is taking active steps to put a stop to this dishonorable trade, and we hope that legislative enactments to restrain it may be put in force in the United States.

NEW METALLIC CEMENTS.

M. Greshiem states that an alloy of copper and mercury, prepared as follows, is capable of attaching itself firmly to the surfaces of metal, glass, and porcelain. From twenty to thirty parts of finely divided copper, obtained by the reduction of oxide of copper with hydrogen, or by precipitation from solution of its sulphate with zinc, are made into a paste with oil of vitriol and seventy parts of mercury added, the whole being well triturated. When the amalgamation is complete, the acid is removed by washing with boiling water, and the compound allowed to cool. In ten or twelve hours it becomes sufficiently hard to receive a brilliant polish, and to scratch the surface of tin or gold. By heat it assumes the consistence of wax, and does not contract on cooling.

New Cement for filling Decayed Teeth, and for other purposes. — M. Feichtinger communicates the following receipt to the *Repertoire de Pharmacie:* — Take of powdered glass one part, oxide of zinc three parts, and mix them intimately. The two substances must be in impalpable powder, and the latter must be free from carbonate of zinc. Then take of a solution of chloride of zinc (density 1.5 to 1.6) fifty parts, borax one part. Dissolve the borax in a little hot water, and pour it into the chloride of zinc; borate of zinc is precipitated, which disappears on agitating the mixture. To make the cement, mix the powder with enough of the solution to form a stiff paste. Only so much as may be wanted at the time should be mixed, as the compound quickly hardens. In the course of a little time it becomes as hard as marble, and remains so, even after prolonged contact with water. If the ingredients are pure, the cement is perfectly white. — *Chemical News.*

PROCESS FOR SILVERING ANIMAL, VEGETABLE, AND MINERAL SUBSTANCES.

Liquor No. 1. — Take two parts, by weight, of caustic lime, five of sugar of milk or grape sugar, two of gallic acid, and make of them a mixture in

six hundred and fifty parts of distilled water; filter, protected from the air as much as possible, and put in a closely stopped bottle until the moment of using.

Liquor No. 2. — Dissolve twenty pints of nitrate of silver in twenty parts solution of ammonia, and add to this solution six hundred and fifty parts of distilled water.

The two preceding liquors are mixed in equal quantities, and, after having been well agitated, are filtered.

As the solution of ammonia of commerce has not always the same degree of concentration, it would be better, perhaps, to dissolve the nitrate of silver destined for the liquor No. 2, first in distilled water, then mix this solution with liquor No. 1, and only then add ammonia in quantity sufficient to entirely clear the mixture, taking care always not to maintain an excess greater than is necessary to prevent the silver from being precipitated.

Suppose it is intended to silver silk, cotton, woollen, etc., we commence by washing the substance clean; this done, we immerse it for a moment in the saturated solution of gallic acid; then withdraw it to plunge it for a second in another solution composed of twenty parts of nitrate of silver to one thousand parts of distilled water. These alternate immersions are continued, until the substance, from being dark, becomes of a brilliant tint; after which it is plunged in a bath composed of a mixture of the two liquors, Nos. 1 and 2. When it is completely silvered it is withdrawn, and boiled in a solution in water of a salt of tartar, and there remains nothing more to be done but a last washing and drying.

Stucco and pottery ought, before being submitted to the operation, to be covered with a coat of stearin or varnish.

The silvered surfaces are then washed with distilled water, dried by free air and heat, and in the last place covered with a layer of varnish. The deposition of silver can be accelerated by the employment of heat; in this case the temperature depends upon the nature of the objects to be submitted to the operation.

As for the metals, we commence by cleaning them with nitric acid; rub them afterwards with a mixture of cyanide of potassium and powdered silver; then, after washing with water, they are plunged alternately into liquors Nos. 1 and 2, until they appear sufficiently silvered. If working with iron, it should be first immersed in a solution of sulphate of copper. — *Jour. de Chim. Med.*

ON THE THEORY OF DYEING.

The following is an abstract of an article on the above subject, by Professor Bolley, of Zurich, Switzerland, published in the L. E. and D. Philosophical Magazine, for December, 1859: —

Two questions have long been agitated among chemists interested in the theory of dyeing. 1. In what part of the colored fibre is the coloring matter situated? Does it merely adhere to the surface, or does it penetrate the entire substance of the cell-walls of such fibres as cotton and flax? Or, lastly, in the case of such fibres, is it stored up in the interior of the cells? 2. What is the nature of the union between the dye and the fibre? Is it a chemical combination, or is it due to mere surface attraction? After comparing the various theories which have been advanced during the last century and discussing the merits of each, the author records the results of his own experiments, from which it appears that wool and silk, in all cases where they have

not been dyed with colors in a mere state of suspension,[1] seem to be impregnated with the dye throughout their entire mass; while in the case of cotton, by far the larger portion of the coloring matter adheres to the surface of the fibre, the penetration of the cell-walls by the dye being either very slight or altogether wanting.

That the theory proposed by Mr. Crum, of England, that the tubular form of the cotton fibres is an essential condition to their taking a dye, is unfounded, appears from the fact that the amorphous cotton-gelatine precipitated from its solution in cuprate of ammonia may be mordanted and dyed like ordinary cotton. In like manner sulphate of baryta and other pulverulent mineral bodies may be mordanted and dyed with decoctions of dyewoods.

With regard to the nature of the force which binds the coloring matter to the fibre,— whether or no it be chemical attraction,— Bolley concludes that there is no sufficient reason for accepting the view, principally developed by Chevreul (and by Kuhlmann, *Comptes Rendus*, Tomes xlii., xliii., *et* xliv.), that dyeing is a direct consequence of chemical affinity. He believes that the power possessed by fibres of attracting certain bodies — whether salts or coloring matters or both — from their solutions, belongs to that class of phenomena which results from the action of finely divided mineral or organic bodies (charcoal or bone-black, for example) on such solutions. The distinction between the action of charcoal and of fibres in thus removing saline matters, or dyes, from their solutions, is one of degree only, the nature of the operation being identical in either case.

A given weight of well prepared animal charcoal can, as a rule, deprive a larger quantity of liquid of its color than an equal weight of wool or silk. Neither wool nor silk can remove all the color from a solution as charcoal can, their effect extending only to a certain degree of dilution beyond which the particles of coloring matter resist their attraction. Dyes which may have been taken up without a mordant by wool, or especially by silk, may be removed again by long washing in water, a fact which is not true in the case of charcoal, or only to a very slight extent. The attraction of coloring matters for water is therefore more completely overcome by charcoal than by animal fibre; but even the cleanest vegetable fibres, as unmordanted and completely bleached cotton, possess a certain power of attracting coloring matter. That cotton should have less effect in this matter than wool or silk is not surprising, in view of the great difference in the structure of cotton fibre as compared with that of the two substances last mentioned. It is well known that wool and silk, in consequence of their physical constitution, belong to the class of strongly absorbent or hygroscopic substances, *i. e.*, in consequence of a certain porosity or looseness of their particles they swell up when moist and become easily penetrated by a liquid throughout their entire mass; on the other hand the cell walls of cotton fibres are denser, less penetrable, and, at the same time, thinner, and therefore unable to contain the same quantity of liquid.

It has been often urged that since fibres, especially those of animal origin, not only exert an attraction for salts, etc., but also possess the power of decomposing some of them, their action must be chemical. But in this respect the behavior of charcoal is similar to that of the fibres. So, too, with regard to the increased attraction for color exhibited by mordanted cotton,

1 In which case the coloring matter only adheres as a crust to the surface of the fibre.

which is on a par with the fact observed by Stenhouse, that the decolorizing power of wood-charcoal is considerably increased by precipitating alumina upon it.

According to the author, mordants act by producing insoluble colors (lakes). Their behavior towards coloring matters in solution must be ascribed to chemical affinity, with which, however, the fibres themselves have nothing to do.

SULPHUR-BLEACHING.

Schoenbein, of Bâsle, has discovered some exceedingly interesting facts relative to this process. The fumes of burning sulphur, as is well known, consist of sulphurous acid, and are extensively employed, especially in bleaching straw hats. The moistened straw, exposed for a time to the action of the fumes, acquires the desired whiteness. Chemical lecturers are in the habit of illustrating this decolorizing power by immersing a flower, as, for example, a red rose, in sulphurous acid gas, or its solution in water. The color is discharged in a short time. Schoenbein has found that the bleaching holds good only for a certain medium range of temperature. A rose thus bleached has its color restored if subjected to the temperature of two hundred and twelve degrees, as may be conveniently done by holding it in a stream of vapor from boiling water. On cooling to the ordinary temperature, it appears white again, and its color may be thus alternately restored and discharged for a great number of times. Schoenbein has also found that water colored by infusion of a red dahlia, and then bleached by sulphurous acid, yields, by cooling, an ice which at twenty degrees below zero is visibly red, but on warming becomes colorless again.

MAUVE DYE.

This exquisitely beautiful dye for silks is prepared by taking equivalent proportions of sulphate of aniline and bichromate of potash, dissolving them in water, mixing, and allowing them to stand for several hours. The whole is then thrown upon a filter, and the black precipitate which has formed is washed and dried. This black substance is then digested in coal-tar naphtha, to extract a brown, resinous substance; and finally digested with alcohol, to dissolve out the coloring matter, which is left behind, on distilling off the spirit, as a coppery, friable mass. This is the dyeing agent producing all the charming varieties of purples known by the name *mauve*, which, as it appears to us, somewhat inappropriately, has been given to this color. The particularity of these purples consists in the peculiar blending of the red and blue of which they are constituted. These hues admit of almost infinite variation; consequently, we may have many varieties of red mauve, and as many of blue mauve, and any depth of tint can be secured. The permanence of these hitherto fugitive combinations is their strongest recommendation.

NEW BLACK DYE.

A new black dye has been recently discovered in Algeria, which is the subject of considerable interest among French chemists and manufacturers at the present time. The discovery has been made by M. Muratere, and is a vegetable substance gathered from a tree which grows in immense profusion all over the colony. It is destined, according to the report made upon its

merits, to replace every other substance in use for the same purpose up to this day, and is more brilliant than any dye hitherto known. The discoverer has registered his patent for its use under the name of "Algerian Campeachy Wood."

DECOLORATION OF INDIGO BY SESQUI-OXIDE OF IRON.

According to Kuhlman, when a solution of blue indigo is acted upon, at the temperature of one hundred and fifty degrees (C), by hydrated oxide of iron, its color is almost immediately completely destroyed. The same thing occurs with a number of other coloring matters. In noticing this fact, Barreswil suggests that persulphate of iron may perhaps be applied in calico-printing as a discharge for indigo, and also in bleaching blue rags for paper-making. —*Répertoire de Chimie Appliquée,* October, 1859.

ON THE RENDERING OF FABRICS INCOMBUSTIBLE.

The *Répertoire de Chimie* publishes a paper from the well-known chemists MM. Dœbereiner and Œlsner, on the various methods for rendering stuffs incombustible, or at least less inflammable than they naturally are. The substances employed for this purpose are borax, alum, soluble glass, and phosphate of ammonia. For wool and common stuffs any one of these salts will do; but fine and light tissues, which are just the most liable to catching fire, cannot be treated in the same way. Borax renders fine textile fabrics stiff; it causes dust, and will swell out under the smoothing-iron; so does alum, besides weakening the fibres of the stuff, and making it tear easily. Soluble glass both stiffens and weakens the stuff, depriving it both of elasticity and tenacity. Phosphate of ammonia alone has none of these inconveniences. It may be mixed with a certain quantity of sal-ammoniac, and then introduced into the starch prepared for stiffening the linen; or else it may be dissolved in twenty parts of water, in weight, to one of phosphate, and the stuffs steeped in the solution, then allowed to dry, and ironed as usual. Phosphate of ammonia is cheap enough to allow of its introduction into common use, so that it may be employed at each wash.

STEINBÜHL-YELLOW, A NEW KIND OF CHROME-YELLOW.

Under the above name a yellow color has been for some time in commerce, which is quite certain to find much favor, although its price is far higher than that of the ordinary chrome-yellow. It is of a splendid yellow, and differs essentially in its tint from the best samples of chrome-yellow. Its components are chromic acid, lime, and potash; and when stirred for a short time with cold water, it parts with chromate of lime.

The poisonous qualities of chromic acid and its soluble salts, and the circumstance that the color parts with perceptible although not large quantities of chromic acid to cold water, render the Steinbühl-yellow an extremely dangerous coloring-matter; and its employment in confectionery, and the like uses, must not be thought of.

PROCESS FOR GIVING OBJECTS A PEARLY LUSTRE.

To produce the irridescence of the mother-of-pearl on stone, glass, metal, resin, paper, silk, leather, etc., Reinsch adopts the following process: Two

parts of solution of copal, two parts of that of sandarach, and four parts of solution of damara resin (equal parts of resin and absolute alcohol), are mixed with half their volume of oil of bergamot or rosemary. This mixture is to be evaporated to the thickness of castor oil. If this varnish be then drawn by the means of a feather or brush over the surface of some water, it will form a beautifully irridescent pellicle. This film is now to be applied to the objects which are to be rendered irridescent. The vessel in which the water is contained, on which the pellicle has been produced, must, therefore, be as large, or larger, than these objects. The water should have about five per cent of pure solution of lime added to it; its temperature should be kept at about seventy-two degrees. The objects to be dried in the sun. — *Journal of Pharmacy.*

USEFUL APPLICATION OF AMMONIACAL CHLORIDE OF ZINC.

By dissolving equal equivalents of chloride of zinc and sal ammoniac, a double salt, composed of these two substances, readily crystallizes in six-sided prisms. This salt possesses the power of dissolving oxide of copper and oxide of iron. It is, therefore, possible, by means of a concentrated solution of the ammoniacal chloride of zinc, to polish rusty spots on iron and copper. In tinning copper vessels, the solution of ammoniacal chloride of zinc is of great advantage: the surface to be tinned is treated with it, and the vessel placed over a charcoal fire; then, when the surface appears perfectly bright, the tin is poured in, so that it may spread over the surface. This method is also applicable for coating with lead. — *Pharmaceutisches Central Blatt.*

ON THE EMPLOYMENT OF CARBONIC ACID IN CONNECTION WITH HYPOCHLORITE OF LIME FOR BLEACHING PAPER-STOCK.

An apparatus, devised by Didot and Barruel, of Paris, for introducing carbonic acid, prepared by burning charcoal, into the solution of hypochlorite of lime (bleaching salt), while the latter is in contact with the fibre which is to be bleached, is described in the Nov. (1859) No. of Barreswil's *Répertoire de Chimie Appliquée*, vol. i. p. 457.

The carbonic acid, on being introduced into the solution of bleaching salt, unites with the lime, thus setting free hypochlorous acid, the decolorizing action of which is infinitely more energetic when it is at liberty than when in combination with a base.

This process, says Barreswil, is of extreme simplicity, and one is at a loss to comprehend why it had not been sooner invented, in view of the fact that each and all of its phases have been so long and so well known.

In order to judge of the practicability of the new process — in so far as concerns difference of price, strength, and whiteness of the paper, and the duration of the operations in the two systems (new and old) — of bleaching, comparative experiments were instituted, by the Messrs. Firmin Didot, upon carefully assorted rags; the cost of the chemicals and labor, and the amount of time required, having been exactly noted. After bleaching, the pulp was converted into paper. The different papers were then carefully tested. As the result of these experiments, it appeared that the new process was more energetic and more rapid than the old method, *au chlore* [*chlorure?*] *liquide* (with solution of bleaching salt), and that in many cases it is also equally energetic with the process in which chlorine gas is employed. Over

the latter it has the advantage of not destroying to so great an extent the fibre of the pulp.

Since the details of the process, which for that matter consists merely of arrangements for thoroughly washing and cleansing the carbonic acid employed, — the latter being then introduced into the bleaching vats, just as if it were steam, through coils of pipe pierced with holes, which are placed at the bottom of the vats, — cannot well be explained without a diagram, we must refer the reader who may desire these to the original article, in which the apparatus is figured. — *Silliman's Journal, F. H. Storer.*

NEW METHOD OF OBTAINING CARBONIC ACID.

M. M. Meschelguck and Lionnet have proposed to the French Academy a new and economical mode of obtaining carbonic acid. It is known that the temperature at which the carbonate of lime is decomposed when vapor of water is passed over it, is lower in proportion as the amount of moisture present is increased; in fact, it will even give off all its acid if heated to 212° in a current of the vapor. The proposed new method of procedure is as follows: Strong earthen retorts, filled with limestone, are placed in a reverberating furnace, and the temperature is raised as needed. The retorts communicate, at the back, with vapor generators, by means of tubes furnished with cocks. When the retorts are at a uniform red heat, the vapor is admitted by opening the cocks, and quantities of carbonic acid gas are at once generated and received into a gasometer.

THE ECONOMY OF GLUTEN.

In our starch factories an enormous amount of gluten is annually wasted, or but imperfectly saved. Walter Crum, the well-known industrial chemist of Glasgow, has devised a means of utilizing this material in dyeing and calico printing. It is well known that many colors, for example, cochineal and archil, which may be readily fixed on wool and silk (animal fibres), have so little affinity for cotton and vegetable fibres as to render the dyeing of the latter with them very difficult or impossible. But a few years ago, a process which is technically designated the *animalization of cotton* was introduced, consisting in coating the cotton fibre with an animal substance. For this purpose, albumen from eggs and blood has been hitherto employed. Crum accomplishes the same object by the use of gluten, which is a vegetable product of the same composition as albumen, but much cheaper than the latter, especially when occurring as a refuse in the starch manufacture.

FILTER FOR CORROSIVE LIQUIDS.

Boettger, of Frankfort, employs for the filtration of corrosive liquids a glass funnel, the neck of which is loosely plugged with gun cotton. This substance, properly prepared, has the proper fibrous, porous texture for an efficient filter, and being a product of the action of the most corrosive agent, viz., mixed sulphuric and nitric acids, is scarcely attacked, even in the slightest degree, at medium temperatures, by any single agent or solvent, so far as known, except acetic ether. It may be employed for filtering strong nitric acid, fuming oil of vitriol, permanganate of potash, strong caustic potash lye, and aqua-regia. Even chromic acid may be separated from its mother liquors by this filter. Its use in drying crystals which have

deposited from corrosive liquids is obvious. The gun cotton employed by Boettger is probably that obtained by the action on cotton of the strongest sulphuric and nitric acids, as that prepared by weaker acids, or by sulphuric acid and saltpetre, is soluble in a variety of agents. — *Silliman's Journal.*

PREPARATION OF SOLUBLE SPICES.

Among the most curious of the modern discoveries in chemistry are the methods of producing, from highly noxious and offensive materials, compounds which possess the properties of the most agreeable flavors and essences, and which serve in actual use as substitutes for the preparations before made from fruits and flowers. At the present time, some of the choicest extracts for culinary purposes are produced from the fetid fusel oil, which is separated from crude brandies and whiskies in the process of rectification, and the most delicious perfumes from substances extracted from the coal-tar of the gas-works, and even from still more offensive products.

A peculiar disgusting compound of sulphur and carbon, obtained as a liquid by condensing the vapor of sulphur after passing it over red hot charcoal, and known as sulphuret of carbon, has long been known as a powerful solvent of India-rubber, for which purpose it has of late years been manufactured in large quantities. It is distinguished for its pungent taste, and a peculiar fetid odor, due to the sulphureted hydrogen which adheres to it. This compound has recently come into use in France, under a patent of M. Bonière, of Rouen, for making what he designates soluble spices, and other soluble preparations of food. By means of it he dissolves out the active principles of the spices, and also of other strongly flavored articles used as condiments, such as garlic, onions, shallot, and various fruits, and causing these to be taken up by some inert body, as gum, sugar of milk, common salt, or other substance adapted to the particular extract, he prepares them for the use of the table, putting them up in vessels intended to be placed upon consoles or etageres, and made attractive by the taste displayed in their ornamentation.

In his process the first object is to purify and deodorize the sulphuret of carbon. This is done in a peculiar distilling apparatus; the liquid as it enters the first still, falling upon a concentrated solution of caustic potash, or of soft sulphate of lead, heated to 140° or 145° Fahrenheit. The vapor then passes successively to other stills, each of which contains solutions of some compounds with an alkaline or metallic base, as of potash, salts of lead, iron, copper, etc., or of barytes. It then condenses in the worm of the still, and is collected under distilled water in a small glass vessel. The sulphuret can also be rectified by simply bringing it in contact with concentrated solutions of the chemical reagents named, and decanting it successively from these many times. When rectified, the disagreeable smell of sulphureted hydrogen has entirely disappeared, and an ethereal product is obtained, somewhat resembling chloroform in its odor, and possessing solvent properties far superior to the impure commercial article, and leaving no trace after evaporation. It is then ready for the preparation of soluble spices, which, as in the case of pepper, for example, is conducted as follows: The spice being ground to powder, is put in iron wire cages, with sheet-iron bottoms. These cages being set in a cylindrical vessel to which they are fitted, the purified sulphuret of carbon is admitted through the bottom of the outer cylinder, and, flowing up through the cages, dissolves out the active

principle of the spice; and, by a side pipe of glass placed near the top, the liquid charged with this principle is let off into a caldron or still. In this is placed some substance, as common salt, or saltpetre, sugar of milk or other sugar, or some other matter, as dextrine, gum, or flour, for absorbing and becoming saturated with the extract. The lower portion of this still is double, and steam at the temperature of 140° to 145° Fahrenheit being introduced in the space at the bottom, the sulphuret of carbon is entirely volatilized, and, passing through the worm of a condenser, is recovered, so as to be used again in successive operations, while the extract is held by the absorbing substance placed in the still. The length of time required for continuing the process, in order to extract all the active principle, is indicated by the color of the liquid which flows through the glass tube leading from the cylinder to the still. The connection between the two is then closed, and the liquor remaining in the cylinder is allowed to flow out through the bottom; after which, steam is admitted to carry off the last portions of sulphuret of carbon, which is collected and condensed in another vessel. By this process the active principle of the spice or fruit is entirely removed from its natural ligneous vehicle, and transferred entirely to sugar, salt, or gum, and this retains no trace of the sulphuret of carbon; and any amount of concentration can be given to the products, according to the relative proportions of the absorbent and of the spice employed.

In the treating of garlic, onions, and such vegetables, the juice expressed by hydraulic pressure is mixed with the sulphuret of carbon, which dissolves its active principle.

IMPROVEMENT IN SOAPS.

Several improvements in the manufacture of soaps and cleansing preparations have been recently patented by Mrs. Rowland, of London. They depend chiefly upon the introduction of certain chemical compounds into ordinary soaps, by which their detersive properties are greatly increased. The soap being dissolved in warm water, ammonia, or some ammoniacal compound, is added to the solution, together with some liquid hydrocarbons, or an equivalent substance, as spirits of turpentine, coal-tar, naphtha, camphene, or some of the similar compounds derived from the distillation of bituminous matters. The proportions of the mixtures are determined by the nature of the soap, and the use required. On account of the volatility of the substances added, much heat is avoided in mixing. It is well to add some flour, dextrine, or some gelatinous or mucilaginous substance which is soluble in water, as it serves as a vehicle for holding the other substances in suspension or mechanical combination. Perfumes or essential oils are introduced to disguise the odor of the chemical ingredients.

The following is a more particular description of one of the processes. Six pounds of soap are dissolved in two pounds of warm water. To the same quantity of water are added about three and a half ounces of flour, starch, dextrine, oatmeal, or some other substance; gelatine, glue, or other gelatinous or mucilaginous substances may be employed, which will give body to the composition, and cause the ingredients to cohere. A paste is thus prepared by boiling, and is added while hot to the solution of soap, and the whole is then heated and stirred till the ingredients are thoroughly incorporated together. It is now taken off the fire, and the stirring is continued till the temperature has fallen to about 100°, when about fourteen ounces of spirits of turpentine, naphtha, camphene, benzole, or other such

substance, is added, together with an equal quantity of a saturated solution of carbonate of ammonia. The mixture should again be thoroughly stirred, and then turned into suitable vessels and hermetically sealed. To the carbonate of ammonia it may be well to add one-eighth its weight of the liquid or caustic ammonia of the Pharmacopeias.

NEW METHOD OF VULCANIZING INDIA-RUBBER.

When flowers of sulphur and dry hypochlorite of lime (bleaching powder) are shaken together, a very strong odor of chloride of sulphur is immediately developed. If the mixture be somewhat forcibly rubbed in a mortar, elevation of temperature ensues, the sulphur softens, and the mixture becomes solid, while abundant vapors are evolved. When a much larger amount of sulphur than that of the hypochlorite is used, and friction is avoided when the two are blended, a mixture is obtained, which, being added to the caoutchouc paste — either with or without the addition of inert matters, such as chalk, oxide of zinc, etc., serving to give body to the product — effects the vulcanization of the latter, either at the ordinary temperature or when gently heated. By this means objects of any thickness can be uniformly vulcanized.

If, instead of employing an excess of sulphur, an excess of the hypochlorite be introduced into the mixture, and this be agitated, so much heat will be developed that the vessel containing the mixture can no longer be held in the hands; if the flask be closed, the action becomes so violent that the cork will be blown out, or the flask broken by a violent explosion.—*M. De Clauberg, Comptes Rendus.*

IMPERISHABLE INK.

Mr. John Spiller has communicated to the London *Chemical News* a paper on the employment of carbon as a means of permanent record. The imperishable nature of carbon, in its various forms of lamp-black, ivory-black, wood-charcoal, and graphite, or black lead, holds out much greater promise of being usefully employed in the manufacture of a permanent writing material; since, for this substance, in its elementary condition, and at ordinary temperatures, there exists no solvent nor chemical reagent capable of effecting its alteration.

The suggestion relative to the mode of applying carbon to these purposes, which it is intended more particularly now to enunciate, depends on the fact of the separation of carbon from organic compounds, rich in that element, sugar, gum, etc., by the combined operation of heat and of chemical reagents, such as sulphuric and phosphoric acids, which exert a decomposing action in the same direction; and by such means to effect the deposition of the carbon within the pores of the paper by a process of development to be performed after the fluid writing ink has been to a certain extent absorbed into its substance,— a system of formation, by which a considerable amount of resistance, both to chemical and external influences, appears to be secured. An ink of the following composition has been made the subject of experiment:—

Concentrated sulphuric acid, deeply colored with indigo,	1 fluid ounce.
Water,	6 " "
Loaf sugar,	1 ounce troy.
Strong mucilage of gum-arabic,	2 to 3 fluid ounces.

Writing traced with a quill or gold pen dipped in this ink dries to a pale blue color; but if now a heated iron be passed over its surface, or the page of manuscript be held near a fire, the writing will quickly assume a jet black appearance, resulting from the carbonization of the sugar by the warm acid, and will have become so firmly engrafted into the substance of the paper as to oppose considerable difficulty to its removal or erasure by the knife. On account of the depth to which the written characters usually penetrate, the sheets of paper selected for use should be of the thickest make, and good white cartridge paper, or that known as "cream laid," preferred to such as are colored blue with ultramarine; for, in the latter case, a bleached halo is frequently perceptible around the outline of the letters, indicating the partial destruction of the coloring matter by the lateral action of the acid.

The writing produced in this manner seems indelible; it resists the action of "salts of lemon," and of oxalic, tartaric, and diluted hydro-chloric acids, agents which render nearly illegible the traces of ordinary black writing ink; neither do alkaline solutions exert any appreciable action on the carbon ink. This material possesses, therefore, many advantageous qualities which would recommend its adoption in cases where the question of permanence is of paramount importance. But it must, on the other hand, be allowed that such an ink, in its present form, would but inefficiently fulfil many of the requirements necessary to bring it into common use. The peculiar method of development rendering the application of heat imperative, and that of a temperature somewhat above the boiling point of water, together with the circumstance that it will be found impossible with a thin sheet of paper to write on both sides, must certainly be counted among its more prominent disadvantages.

ACTION OF PROLONGED HEAT AND WATER ON DIFFERENT SUBSTANCES.

Mr. H. C. Sorby communicates to the French Academy an account of some experiments he has made on the above subject. He put different substances and various solutions in glass tubes, sealed them hermetically, and then placed them in the boiler of a high-pressure engine, and kept them there, exposed to a temperature ranging from one hundred and forty-five to one hundred and fifty degrees Centigrade, for some months. Others he placed in an ordinary kitchen boiler, in which the temperature varied from seventy-five to one hundred degrees Centigrade. The first facts noticed are the decomposition of the glass tubes employed. Crown glass resisted the action best, — better even than Bohemian, — but it was sometimes acted on at but slightly elevated temperatures. English flint glass was easily decomposed by the prolonged action of water below one hundred degrees. A fragment of flint or Bohemian glass, enclosed in a tube of crown glass with a little water, was more quickly decomposed than with much water. A moderately strong solution of nitric acid had little or no action on flint glass at one hundred and forty-five or one hundred and fifty degrees, while pure water soon changed it into a white crystalline mass. Wood, exposed to a temperature of one hundred and forty-five degrees, without water, underwent but little change, while some with water became quite black. A brilliant black substance separated from the wood, but the water remained quite clear, although it had an acid reaction, due, no doubt, to acetic acid, and when the

tube was opened a good deal of gas escaped. Some of the results obtained illustrate the pseudomorphosis of minerals. — *Chemical News.*

NEW PROCESS FOR THE MANUFACTURE OF SULPHURIC ACID. — BY MR. SHANK.

This process, the success of which is as yet very problematical, is based upon the separation of the acid from gypsum by means of two successive chemical reactions, namely, the decomposition of the sulphate of lime by means of chloride of lead, and that of the sulphate of lead thus resulting by means of hydrochloric acid. For this purpose, in a cistern of greater length than depth, formed of sheet-lead, or masonry, or any other material not affected by acids, are placed eighty-six parts of gypsum, or eighty-six parts of calcined plaster, and one hundred and forty parts of chloride of lead. To these are added a large quantity of warm water, and the whole well mixed and stirred. An immediate reaction takes place, sulphate of lead forming as a precipitate, while chloride of calcium goes into re-solution. The stirring continues until the supernatant liquid is free of lead, which is to be ascertained by the usual reagents. The liquor is then removed by decantation, while the sulphate of lead remains in the cistern. For the decomposition of the sulphate of lead, hydrochloric acid is added in somewhat larger proportion than that indicated by the chemical equivalents, the temperature of the mixture is raised, and the reaction is finished. The chloride of lead which forms is precipitated, while the supernatant liquid is nothing but a solution of sulphuric acid. When cold, this is decanted and concentrated by evaporation to the strength required in commerce. The chloride of lead remaining in the cistern is washed with cold water, which removes the greater portion of the adhering sulphuric acid, whereupon the same proportion of sulphate of lime is added as before, and the whole process is recommenced. In this way the chloride of lead is used over and over again, without any loss but that caused unavoidably during the manipulation.

CHEMICAL SUMMARY.

An Impervious Paper has been patented in England, which is prepared in the following manner: A solution of soap is added to the paper-pulp in the proportion of two ounces of solid soap to every gallon of pulp, and when thoroughly incorporated, enough of a solution of alum is added to decompose the soap and form a compound of the fatty acid and alumina. This alumina-soap replaces the sizing, and renders the paper manufactured from it impervious to water.

Extract of Hops. — M. Ramont asserts that he has obtained, by treating hops by boiling water in a close vessel, an extract, which he calls *houblonine,* which contains all the active, aromatic, bitter, and astringent principles of the hops; and that by means of this extract the manufacture of ale may be greatly ameliorated. — *Cosmos.*

Means of Removing the Rancidity of Butter. — Wild recommends that the butter should be kneaded with fresh milk and then with pure water. He states that by this treatment the butter is rendered as fresh and pure in flavor as when recently made. He ascribes this result to the fact that butyric acid, to which the rancid odor and taste are owing, is readily soluble in fresh milk, and is thus removed. — *Pharm. Jour.*

Paper Parchment.—Mr. Thomas Taylor communicates to the *Chemical News* a new process of making this curious substance. Instead of immersing the paper in dilute sulphuric acid, he employs a concentrated solution of chloride of zinc. The paper is reduced in volume, but made tougher, stronger, and semi-transparent. The highest effect is produced by using the solution hot. Pieces of paper thus saturated can be united by ironing.

On the Cleaning of Glasses, etc.—There is often a difficulty in cleaning glasses or porcelain capsules to which organic matters have adhered and in course of time have become so hard and dry as to resist all solvents. The following process will be found to answer in almost every case: The spots to be cleaned are moistened with concentrated sulphuric acid, and powdered bichromate of potash is sprinkled upon the acid; the objects are then left standing for some hours (through the night) in a moderately warm place. All organic matters are by this means destroyed, with formation of sulphate of chromium, which may be removed by water with the residue of the acid. —*Dingler's Polytechnic Journal.*

Colored Flames.—Mr. A. H. Church, writing in the *Chemical News*, states that blotting paper prepared like gun cotton, by ten minutes' immersion in four parts of sulphuric and five of strong fuming nitric acid, and then washed and dried, produces beautiful flames if soaked in chloride of strontium, or barium, or copper, or nitrate of potassa. Pellets thus prepared and thrown alight into the air produce a flash of intense light. The barium salt gives a green color, strontium a crimson, potassa a yellow, and copper a fine blue.

New Material for Pencils.—Some black lead in powder mixed with India-rubber in solution, a small quantity of lampblack and some finely powdered charcoal, are incorporated together and subjected to great pressure. This forces out all the moisture and reduces the mixture to a hard block, which may be subdivided and cut out into suitable lengths for pencils. A patent has been taken out for this pencil composition by R. J. Cole, of London.

Oxalic Acid abounds in certain of our culinary vegetables; and it may undoubtedly be employed to a certain extent with impunity. Still, it is not a desirable ingredient in human sustenance; and I am in the habit, when the opportunity offers, of telling housekeepers to throw away the first water which exudes in cooking rhubarb, now so generally used; that is to say, if rhubarb intended for tarts or pies be first heated in an oven, after being peeled and otherwise made ready for cooking, before the sugar is added, it will be found to discharge a large quantity of a watery, and, at the same time, very acid juice. When this water, containing mixed acids, is rejected, the rhubarb forms a very much more agreeable, as well as much more wholesome dish.—*Dr. McCormack, in the London Medical Times.*

Œnanthic Acid.—It will be remembered that Liebeg and Pelouze many years ago announced the discovery of an ethereal essence which gave the rich flavor to wine, and which they styled œnanthic ether. Their researches were followed up by other investigators, and œnanthic acid took its place in chemistry. Mr. A. Fischer now announces that this acid does not exist, and that what has received the name is merely a composition of caprylic and capric acid.

Quinic Acid in the Herb of the Whortleberry.—Messrs. Zwenger and Siebert (*Annalen der Chimie u. Pharmacie*, July, 1860) have found that several plants belonging to the family of Ericineæ, among them the Vaccinium Myrtillus,

whortleberry, contain a considerable proportion of quinic acid, identical with that obtained from Peruvian bark.

On the Preservation of Yeast. — M. Changy, a French chemist, states that yeast, whether solid or liquid, if mixed with a certain quantity of animal or vegetable charcoal, and afterwards dried, either by a current of air or by a rotating apparatus, produces a powder which preserves for an unlimited period its fermenting properties.

Oxidation of Organic Matter. — Mr. G. T. Glover, writing in the *Chemical News,* recommends oxidizing organic matter in analysis for the detection of mineral poisons, by conveying through the mass to be examined the gas evolved when chlorate of potash is treated with dilute muriatic acid. He represents this process as avoiding the inconvenience of mixing the chlorate of potash with the substance itself.

New Dye. — An Austrian is said to have discovered a carmine dye in the Chinese sorgho. The plant is allowed to ferment, and then treated with caustic soda or potash, which dissolves the coloring matter. It is then precipitated by sulphuric acid.

Curious Action of Silver. — Professor Boettger states that if dry oxide of silver is moistened with essence of cloves, the mixture takes fire and the metal is reduced.

Suggestions for Removing Ink Spots. — If the ink is the common nutgall and iron ink, a solution of oxalic acid will remove the spot at once. Those from ink which contains indigo, if on paper, are first bleached with chlorine water and then removed by hydrochloric acid; if on linen, first with a solution of hydrochlorite of lime or Labarraque's solution, and then with acid. Blue ink is removed by treating the spot first with some alkali, and washing it afterwards with some acid.

Benzinated Magnesia for the Removal of Grease Spots. — Lumps of carbonate of magnesia (calcined magnesia will answer the same purpose) are saturated with benzole, and spread over the grease spot a sixth of an inch thick. When dry, the magnesia is simply dusted off, but the operation is repeated if necessary. This method of applying benzole in combination with the capillary action of the magnesia is said to be superior to any other for the removal of fresh and old spots from all kinds of wood, ivory, paper, parchment, silk, and cotton: for woollen it is not adapted, on account of the magnesia becoming fixed in the grain.

Coal-Oil as a Preservative for Sodium and Potassium. — Coal-oil is a better article for preserving sodium and potassium than naphtha. In coal-oil, sodium keeps its lustre for months or years, while in the purest naphtha it loses it in a few days. — *Correspondence Journal Franklin Institute.*

Action of Sulphuretted Hydrogen on Silver. — It has been shown by MM. Davanne and Girard that perfectly dry sulphuretted hydrogen does not act upon silver. Silver leaves may be suspended in a perfectly dry atmosphere of this gas without undergoing change.

Adamantine Boron. — This name is applied by Deville to a new combination of aluminum and boric acid, recently prepared by him, which possesses most remarkable properties. It is harder than the diamond, will cut and drill rubies, and even the diamond itself, with more facility than the diamond powder.

Gas-Lime as a Depilatory. — As is well known, the Turkish *rusma* owes its action on the hair to the persulphide of lime it contains, the arsenic present being only the bearer of the sulphur. A writer in the *Polytechnische*

Central-Halle gives the following as the rationale of the process now in use by tanners with gas-lime. The depilatory action depends exclusively upon the persulphide of lime, and is heightened by the presence of cyanide of calcium. Pieces of hairy skin brought into a mixture of these two compounds were at once deprived of the hair, the destruction commencing on the ends and stopping at the root without acting in the least on the skin. It appears that one atom of sulphur combines with the substance of the hair, destroying it, and at the same time leaving an insoluble sulphate of lime which is precipitated together with the decomposed hair.—*Druggists' Circular.*

Chlorined Water in Dissection Wounds.—M. Garrigon states that repeated experience has convinced him of the efficacy of the treatment long since recommended by M. Nonant, of placing the hand suffering from dissection wounds in chlorinated water. The application will always be found efficacious, providing purulent infection have not already set in, when it will be useless.—*Gaz. des Hôp.*, 1859, No. 30.

Sulphur as a Dentifrice.—Dr. C. W. Wright states, in an article on the above subject, in the *Louisville Medical Gazette,* that the common flowers of sulphur of the drug-store possesses advantages over all other substances on account of its antiseptic properties, its exerting no injurious action on the teeth, either chemical or mechanical, and its ready preparation and cheapness. The sublimed sulphur must be freed from any acid which it may contain by agitating it in water in which a small quantity of carbonate of soda has been dissolved, and then freed from the soda by repeated washing in cold water.

THE PHILOSOPHY OF STINKS.

There is a fallacy in the almost universal opinion that, because a stink is unpleasant, it must necessarily be injurious to health. Yet a very small survey of familiar facts would disclose that our likings and dislikings in the matter of smell or taste are by no means accurate criteria of what is wholesome and what is noxious. Unfortunately, we like many things that are notoriously injurious; and many things that are unpleasant are notoriously beneficial. Not only are these familiar truths, but a little inquiry discloses a mass of evidence which proves that even the odors of a too composite river or an ill-drained district, unpleasant as they may be, are very far from carrying pestilence and plague with them wherever they go. We are not going to assert that the question of drainage is not very important.. We have no desire to propound the paradox that stinks are wholesome because disagreeable; but we call attention to the fallacy of assuming that because they are disagreeable they must necessarily be injurious.

Is it a demonstrated fact that the exhalations from a foul river cause cholera and fever? So far from its being demonstrated, the evidence at present seems decisively opposed to such a conclusion. Is it demonstrated that the exhalations from the sewers cause cholera and fever?

The public, generally, has no doubt upon the subject, but an English physician of some note, Dr. Parkin, has recently, in a published work, assumed the position that the evidence we possess in regard to these matters is altogether against the theory that cholera, fever, and other diseases are owing to the decomposition of organic matter and the use of impure water. His evidence is founded on experience of very various climates and latitudes,—the intertropical regions of the East and West, the burning sands of Arabia and the snow-covered steppes of Russia, as well as the more temperate regions

of Europe and America,—evidence which, if not conclusive, is at least exceedingly interesting.

Thus, the injuriousness of imperfect drainage is said to arise from the noxious influence of all organic matters—animal and vegetable—when in a state of decomposition. That putrid flesh and vegetables are generally unpleasant, both to taste and smell, is a fact; but are they as injurious as they are unpleasant? Some putrescent matters are injurious when eaten, although many can be, and are, eaten with impunity; and all of them are injurious if they enter the blood. The surprising fact that the Indians kill their game with poisoned arrows, yet suffer no harm from eating the flesh thus poisoned, is intelligible to the physiologist, who sees that the poison of the arrow enters the blood of the animal; but the poison of the poisoned flesh, which is eaten, does not enter the blood. It is on the same principle that we can explain why an anatomist may spend day after day over putrid bodies (in an atmosphere the stench of which makes a stranger sick), yet suffer no harm beyond what would result from sedentary confinement in any other room; nevertheless, let this anatomist scratch himself with the scalpel which he has just used, and this little wound may be his death. He could breathe the air laden with the products of decomposition, and, if oxygen were sufficiently abundant for respiration, no harm would ensue; but he could not admit decomposing matter into his blood without serious injury.

In the above paragraph we have briefly stated what seems to us the physiological principle involved in this question. Putrid substances are poisonous only in the blood; but the gaseous products of putrescence are not poisonous. A stink is unpleasant, but it is not poisonous. We assume, of course, that the gaseous products are not too abundant to prevent respiration, otherwise the effects of imperfect respiration will ensue; but these are not cholera or fever.

With this preliminary explanation, let us now look at Dr. Parkin's evidences.

Majendie arranged a cask in such a way that the bottom could hold putrid substances, whilst animals were placed on a grating with a double bottom, exposed to the emanations which constantly escaped. Rabbits, guinea-pigs, and pigeons were left thus for a month, but did not experience any ill result. Dogs, on the contrary, began to lose flesh on the fourth day, and, although they preserved their gayety and appetite, died at the end of ten or fifteen days. But the dogs showed none of the symptoms of poison;—they showed none of the symptoms observed in dogs into whose veins putrid matters had been injected. Their death was obviously caused by imperfect respiration. Rabbits and guinea-pigs require less oxygen in a given atmosphere than dogs, by reason of their smaller size. But that exhalations from decaying matters are not injurious when respiration is unimpeded, seems evident from the experience of leather-dressers, knackers, butchers, and others. Mr. Newman informs us that the leather-dressers in Bristol are not only healthy, but more so than the rest of the neighboring poor, although, during the last part of the process, the stench is almost intolerable. In the tan-yards at Bermondsey there are about seven hundred workmen, all remarkably healthy. Again, Dr. Chisholme says that, in a manufactory near Bitton, for the production of muriate of ammonia and sulphate of soda, and where the distillation of the medullary oil produces the most nauseating fetor, no fever is known to arise, although the neighborhood is thickly populated. The same exemption has been remarked at a manufactory near Bristol for the conversion of dead animals into a substance resembling spermaceti, and where the

same putrid exhalations are given out. Further, slaughter-houses, which, according to theory, ought to be centres of pestilence and fever, have been singularly exempt from them, as was noticed during the plague and during the cholera. Dr. Tweedie says: "Though every description of mechanic was at some period or other admitted last year into the Fever Hospital, I do not recollect a single instance of a butcher being sent to the establishment."

The perfume of the graveyard is far from agreeable, and graveyards have for some years been regarded as centres of pestilence and fever. When pestilence and fever are raging in a district, it is not difficult, of course, to find that a graveyard is somewhere close at hand; but this is extremely imperfect evidence of any necessary connection between the two; and it becomes still more suspicious when we find that at Bridgetown, Barbadoes, eight thousand bodies were buried in six weeks in a space of two acres, yet neither fever nor any other disease attacked the inhabitants afterwards. The same remark applies to nearly all the large towns in the West Indies, in consequence of the practice of burying cholera victims in one spot. In the burial-grounds near Seville, ten thousand bodies had been recently interred, when, in 1800, the French government sent a commission to inquire into the cause of yellow fever; and although a fetid odor was exhaled from the decomposing bodies, no ill result followed to the thousands of the inhabitants who went daily to visit the graves of their relatives and friends. And what shall we say to the Cemetery of the Innocents at Paris? In the course of thirty years, ninety thousand bodies had been buried there by one grave-digger, and it was calculated that more than six hundred thousand bodies had been buried there during the six previous centuries. In a space not exceeding two acres, it had been the custom to bury the bodies of the poor in common pits, and they were placed so close to each other as to be only separated by planks of six lines each. These pits were twenty feet wide and twenty deep, and each contained ten to fifteen hundred bodies. It is difficult to understand how Paris escaped from continuous attacks of cholera, and how the grave-digger managed to breathe this atmosphere during thirty years, if grave-yard exhalations are the fatal poisons they are declared to be.

The authority of Duchâtelet is invoked in a very striking case. At Montfaucon, in Paris, there is one of the most extensive knacker-yards in the world. Thousands of horses, dogs, and cats are slaughtered there,—the flesh and offal, after the animals are skinned, being allowed to remain and putrefy for the purpose of manure. "Every one," says Duchâtelet, "can examine the fetid odor produced by heaps of flesh left to putrefy for months in the open air, and in the heat of the sun; to which must be added the gases given out from mountains of skeletons not properly cleansed from the soft parts, and the emanations arising from a soil saturated from year to year with blood and animal liquids. But, if you interrogate the numerous workmen who belong to the establishment, they will answer that they are never ill, and that the effluvia which they inhale, far from injuring them, contributes to keep them in good health. If you examine them you will see they have all the appearance of the most perfect health. The robust health of the wife and five children of Friand were remarkable, for they had all the year worked and slept in a place which was actually unapproachable to the members of the commission, on account of the stench." He also notices the longevity of those knackers. "Many of them are sixty or seventy years old, quite robust and active. Inquiries showed that their parents died at an

advanced age; of the last three knackers that died, one was sixty, another seventy, and a third eighty-four."

Such are some of the facts adduced by Dr. Parkin in support of his views, and sanitary reform will not be aided by eluding or suppressing them.—*Abridged from the London Review.*

RESEARCHES ON FERMENTATION.

M. Pasteur, of Lille, has recently been awarded a prize by the French Academy for his researches on fermentation, which throw much light on this little-understood department of chemistry.

He shows that the germ in which fermentation originates is a living substance,—organic, not inorganic, as some suppose; and leads to the conclusion that there is a remarkable analogy between fermentation and physiological action. In fermentation with yeast, for example, there is a perpetual renewal of the yeast, and, at the same time, certain curious relations appear between vital phenomena and mineral substances. Introduce yeast globules into a mixture composed of candied sugar, ammoniacal salt, and a phosphate, and the ammonia will disappear by transformation into the complex albuminous matter of the yeast, while the phosphate gives itself up to form new globules. One of the elements of yeast is carbon, and this, in the present example, is derived from the sugar. M. Pasteur further explains and illustrates the process of lactic fermentation, which most chemists have considered as organic matter in course of alteration; but the lactic yeast is now shown to be really an organized substance, composed of globules, which are smaller than those of the yeast of beer. In the fermentation of tartaric acid, a further discovery was made of a surprising nature: among substances known to opticians are right-handed and left-handed tartrate of ammonia, so named from the direction in which their solutions rotate rays of light. They have no effect on polarized light; but, in the experiments here referred to, fermentation took place in the right-handed only, while the left-handed, similarly prepared, did not ferment, but underwent a change in which it was found to act with energy on polarized light.

The analysis of yeast given by M. Pasteur, on the authority of M. Payen, is as follows: One hundred pints contain 62.73 of nitrogenized matter, 29.37 of cellulose envelopes, 2.10 fatty matter, and 5.10 mineral matters. From this it is evident that the yeast plant can only grow where it can obtain a due supply of nitrogenous and mineral matter. When, by the presence of a salt of ammonia and phosphates, these conditions were abundantly supplied, M. Pasteur found the development of the yeast plant rapid and the fermentation exceedingly active; but when the growth of the plant could only take place through the assimilation of albuminous substances that were already appropriated, as in grapes, beet-roots, etc., the same processes went on, but with diminished velocity.

In most chemical works it is stated that alcoholic fermentation takes place under two circumstances, in which yeast is added to pure solution of sugar, or to a solution containing albuminoid substances. In the first the yeast is said to act, but not to reproduce itself, as in the manufacture of beer; and Liebig observes, that if the fermentation was a consequence of the development and multiplication of the globules, they would not excite fermentation in pure solution of sugar, which does not offer the essential conditions of their vital activity. To this M. Pasteur replies, that his observations and

experiments suggest different views, and afford a certainty that in the cases specified the phenomena are essentially the same, and that in both the yeast globules multiply; but that, in the first case, when the fermentation is concluded, all the globules, young and old, are deprived of their soluble nitrogenized matter, and that what they possessed of nitrogenous aliment has become insoluble and fixed in the fresh globules that have been formed. Yeast in this state has no action upon pure sugar. In the case of fermentation in the presence of albuminoid matters, many globules become exhausted, but most of the new ones leave the liquid filled with nitrogenous and mineral matter, and able to live upon them in a fresh solution of sugar.

M. Pasteur also notes the fact, that succinic acid and glycerine are products of fermentation; and the formation of the former substance appears to exercise an important influence on the flavor of alcoholic drinks, although the quantity is small. Good Bordeaux contains 7.412 grains of glycerine in a litre, and 1.48 grains of succinic acid. M. Pasteur remarks, "The flavor of this acid is peculiar, and when it is mixed with water, alcohol, and glycerine, in the proportions obtained by fermentation, one is surprised to observe the extent to which the mixture resembles wine."

The conclusion of M. Pasteur's paper expresses a conviction that a just consideration of the facts he adduces will show that alcoholic fermentation is an act correlative with the life and the organization of the yeast globules, and not with their death or putrefaction.

Professor Van den Brœk, of Utrecht, also publishes the following conclusions he has arrived at, respecting processes of fermentation and putrefaction: —

1. Fresh juice of the grape, which has never been in contact with the atmosphere, and has been kept absolutely free from it, suffers no change in a temperature of 26° to 28° C. (80° to 83° F.) after months or even years.

2. The fermentation of grape-juice depends upon the vegetation of the yeast cellules, and is, therefore, absolutely dependent upon their development and growth.

3. It has, as yet, not been conclusively demonstrated whether any yeast globules or their germ are present in the juice of ripe and perfect grapes.

4. The impulse necessary for the development of the cellules and for the commencement of fermentation is not given by the oxygen, but by one or more agents contained in the air, which may be destroyed by heat, or retained by filtering it through cotton. These agents may be wanting in a limited volume of atmospheric air, a case not at all rare. In this point fermentation is allied to other species of vegetation, such as mould, the formation of which is dependent upon the very same conditions.

5. Fermentation in fresh grape-juice is induced by the introduction of yeast only and alone, which must not be too old; no atmospheric agents are required, and the yeast itself need never to have been in contact with the atmosphere.

6. Fresh grape-juice, after being exposed for some minutes to the temperature of boiling water, frequently ceases to ferment in contact with atmospheric air.

7. Oxygen, although it does not induce fermentation, acts decomposingly upon the fresh as well as the boiled juice, by being absorbed and forming carbonic acid; the fresh juice, and the parenchyma of the grapes suspended in it, assume under its influence, in a short time, a brown tint, which turns gradually darker.

8. Ozone has no action upon either spirituous or lactic fermentation, or upon the formation of mould.

9. The white and yolk of egg, arterial blood, gall and urine of dogs, or beef, in their fresh state, suffer no change after death, being moist and at a temperature of from 80° to 90° F., if never brought into contact with atmospheric air.

10. In contact with pure oxygen, or with atmospheric air that has been filtered through cotton, neither of the above substances is brought to putrefaction. Still, the oxygen exerts a certain action, inasmuch as they all change their appearance, and the white and yolk of egg, as well as the gall, assume an acid reaction. The beginning of putrefaction, therefore, depends upon some one or more agent which is commonly contained in atmospheric air, and which is removed from it by cotton.

11. Animal matter which is already in a state of putrefaction, or such which has been exposed to the atmosphere for only twenty-four hours, and, consequently, shows no outward signs of decomposition, induces putrefaction in all the above-named substances without the aid of the atmosphere.

12. The microscopic examination of the above-named animal substances has shown that there exists no relation between their putrefaction and between the development and growth of vibrios and other microscopic organisms.

13. In view of all this, we must look to Liebig's chemical theory for a solution of the process of putrefaction, with the reservation, however, that the chemical ferment which induces the putrefaction acquires this property, not by contact with oxygen merely, but with that ingredient of the atmosphere which is retained by cotton. Without this, that theory would not be applicable for the fermentation of grape-juice.

ON THE PRODUCTS OF THE DISTILLATION OF ORGANIC MATTERS. BY M. E. KOPP.

The dry distillation of organic matters, whether vegetable or animal, from the great variety of products to which it gives rise, constitutes one of the most interesting operations of chemistry. The reactions to which these products owe their origin are very complex, and some of them have been but little studied, as indeed is the case with many of the substances formed. If the body submitted to dry distillation could be maintained during the operation under uniform conditions of desiccation, temperature, and pressure, the reactions and the products would be much more simple. If, for example, wood be heated very slowly in a close vessel, first to one hundred degrees Centigrade, then to two hundred degrees, three hundred degrees, and so on, there is at first disengaged almost pure water, then impure, strong acetic acid, and afterwards a mixture of acetone and acetate of methylene; the maximum of charcoal is left as residue, and the least amount of tar and gas is produced, the latter consisting only of carbonic acid and carburetted hydrogen.

In practice, however, when wood is distilled in cylinders of iron heated from the outside, the heat only penetrates to the interior gradually. The outside layers are therefore the first decomposed; they at first lose water; then furnish pyroligneous acid and wood-spirit, at the same time giving off carbonic acid and a little carburetted hydrogen. The inner layers in turn are similarly decomposed; but the products as they are given off are brought

into contact with the outer layer, already in a more advanced state of decomposition, and at a much higher temperature, and hence new reactions take place and new products are formed. Thus, the vapor of water in contact with red-hot charcoal is decomposed, and forms carbonic acid and hydrogen; a part of the carbonic acid is again decomposed by the red-hot carbon to form some carbonic oxide; a part of the nascent hydrogen combines with carbon to form various hydro-carbons; one part of the acetic acid is decomposed by the high temperature to form acetone and carbonic acid; another part reacts on the wood-spirit and forms methylic acetate; a fraction of the wood-spirit and acetone are also decomposed, producing tarry matters, pyroxanthine, oxyphenic acid, dumasine, etc. To these must be added the influence of certain nitrogenized bodies, and we can understand how all these compounds, successively formed under the most favorable circumstances for acting on one another, since they are in the nascent state, and exposed to a high temperature, may give rise to the formation of a great variety of very different compounds, which will be set free either in the state of a permanent gas or a condensable vapor, and leave fixed carbon as a residue. The same takes place whether wood, coal, bituminous schists, boghead coal, asphalte, peat, resin, oils, or animal matters be distilled; but it is evident that the original composition of the material submitted to dry distillation must powerfully influence the nature and composition of the products. In those which, like wood, are rich in oxygen and poor in nitrogen, the pyrogenous products contain much acetic acid and but little ammonia, and consequently have an acid reaction; on the contrary, the matters containing much nitrogen and but little oxygen, like coal and animal matters, give rise to the formation of much ammonia, and the products have an alkaline reaction.

The following table exhibits the great variety of products which are obtainable from the ordinary coal-tar of gas-works, by distillation and rectification: —

Table of the Products obtained by the Distillation and Rectification of Coal-Tar.

Solid Products.	Liquid Products.			Gaseous Products.
	Acids.	Neutral.	Bases.	
Carbon.	Rosolic.	Water.	Ammonia.	Hydrogen.
Napthaline.	Brunolic.	Essence of tar.	Methylamine.	Carburetted hydrogen.
Paranapthaline or Anthracene.	Phenic, or Phenol.	Light oil of tar.	Ethylamine.	Bicarburetted hydrogen.
Paraffine.	Acetic.	Heavy oil of tar.	Aniline.	Various hydrocarbides.
Chrysene.	Butyric.	Benzole.	Quinoline.	Carbonic oxide.
Pyrene.		Toluole.	Picoline.	Sulphide of carbon.
		Cumole.	Toluidine.	Carbonic acid.
		Cymole.	Lutidine.	Hydrosulphuric acid.
		Propyle.	Cumidine.	Hydrocyanic acid.
		Butyle.	Pyrrhol.	
		Amyle.	Pætinine.	
		Caproyle.		
		Hexylene.		
		Heptylene.		

ON THE VALUE OF COAL-TAR AND ITS PRODUCTS.

It is interesting, since coal-tar has acquired so important a position in the arts, to trace how its various products successively rise in value. The prices in Paris are given by M. Parisel in a recent paper as follows: —

Coal, ...	¼	c. per lb.	Ordinary aniline,	$3,27 a $4,90	per lb.
Coal-tar, ...	¾	" "	Liquid aniline violet,	28 a 41 c.	"
Heavy coal-oil, . .	2½ a 3¾	" "	Carmine aniline violet, . .	32c. a $1.92	"
Light coal-oil, . .	6¾ a 10¼	" "	Pure aniline violet, in powder,	$245 a $326.88 "	"
Benzole, . . .	10½ a 13	" "			
Crude nitro-benzole,	57 a 61	" "			
Rectified nitro-benzole,	82 a 96	" "			

The last is equal to the price of gold. And so, says M. Parisel, from coal, carried to its tenth power, we have gold; the diamond is to come.

ON THE EMPLOYMENT OF COAL-TAR AS A DISINFECTANT.

The use of a mixture of coal-tar and plaster-of-paris for purposes of disinfection and for dressing wounds, as proposed by Corne and Demeaux,[1] has recently been reported upon in the French Academy by a committee — Chevreul, J. Cloquet, and Velpeau — to which the subject was referred in July, 1859.

In numerous experiments, made at the Hospital *de la Charité*, the mixed coal-tar and plaster of Corne was employed, both in the state of powder and as a poultice made by mixing it with oil. When applied as a thick layer, three or four times a day, upon putrid, gangrenous, and sanious wounds, the powder destroyed their odor, without giving rise to any special pain. Upon indolent sores, however, or upon recent burns, the contact of the powder produced considerable smarting upon some patients, though well borne by others. Wounds of the first class were often found to be cleaned as well as disinfected; while those of the second class generally acquired a dirty, pale-gray tint, their cicatrization being hindered.

The poultices were found to be more advantageous than the powder in the treatment of cavernous wounds, purulent or fetid, and sinuous foci, open suppurating abscesses, anthracoidal suppurations, etc.

Applied directly to the sore, the poultices destroyed the putrid odors, allayed the inflammation without augmenting the pain, leaving beneath them a healthier pus, and the surfaces in better condition. In a word, the mixed coal-tar and plaster, when properly applied, disinfects wounds and putrid suppurations. As for the absorbent and detergent qualities which its inventors also claim for it, these are less clearly evident.

The powder absorbs better than the poultices; the latter, it is true, take up a portion of the morbid exudations, but unless the dressing is carefully renewed five or six times a day, pus will nevertheless collect beneath it. From this it follows, that after having been somewhat cleaned the wound ceases at the end of a few days to clean itself, or to heal more rapidly than it would with the usual topical applications.

It is in the dissecting-room, upon organic matter in a state of putrefaction, that the mixed coal-tar and plaster is all-powerful. The most infectious masses, when imbued with the powder, or simply rolled about in it, lose at once their disagreeable odor. According to Velpeau, his autopsy room was as approachable towards the close of last summer as it had formerly been repulsive. It was freed from flies and other insects, as well as from putrid odors.

Although it would have been out of the province of the committee to

[1] See Annual of Scientific Discovery, 1860, pp. 268–69.

experiment upon the application of this mixture in disinfecting filth upon the great scale, they have, nevertheless, proved that it can be advantageously used in hospitals for deodorizing urine or fecal matters.

The following inconveniences to which the use of the mixture in surgery would give rise, are enumerated: —

It not only soils the clothes of the patient, but hardens them, and causes them to weigh more heavily upon or about the wound; it imparts to the bandages with which the poultices are covered a very tenacious rusty or yellow color; it must be frequently renewed; and although it destroys putrid smells, it retains a bituminous odor by no means agreeable to many persons.

These inconveniences are of comparatively slight importance, it is true, and may possibly admit of being remedied.

Of the other disinfectants submitted to the committee, several were only modifications of that of Corne and Demeaux. Vegetable tar, as shown by Renault, may be substituted for coal-tar. With regard to the assertions of some practitioners, that common earth, talc, flour, or other vegetable and mineral powders, — even poudrette, — when mixed with coal-tar furnish a more convenient and less costly disinfectant than that prepared with plaster, the experiments of the committee have proved, that while coal-tar, mixed with common earth, well dried, or with sand, is equally, or perhaps much more, efficacious for disinfecting fecal matter as when mixed with plaster; that while comparative experiments made from this point of view upon sulphate of lime, clay, charcoal, linseed-meal, and earth have resulted in favor of the latter, the same is by no means true in surgery. When applied to wounds or infectious suppurations these different mixtures were only partially successful, having proved to be less efficacious than the mixed plaster and coal-tar.

Although the modifications of Corne and Demeaux's process have not been particularly felicitous thus far, they have nevertheless served to confirm the fact that in reality it is the coal-tar which acts the principal part as disinfectant in these various mixtures.[1]

[1] The inefficiency of sulphate of lime as a general disinfecting agent, when used by itself, may be readily demonstrated by the following experiment, which is of interest in view of the fact that a belief in the utility of gypsum as a deodorizer appears to be widely spread among recent writers. For that matter, we are told by Paulet (*Comptes Rendus*, xlix., 199) that during the last twenty-five years more than fifty authors of processes of disinfection have announced, each as he believed for the first time, the use of plaster as a means of disinfection.

If a mixture of about equal volumes of powdered gypsum and fresh urine be introduced into a small phial, the mixture placed in a warm room and thoroughly shaken several times a day until the urine has become putrid, it will be observed that an exceedingly disagreeable odor will be developed, differing from ordinary stale urine, inasmuch as it is unalloyed with the odor of ammonia. For the complete success of this experiment, it is important that a large excess of sulphate of lime should be present, and that the mixture should be frequently agitated, else the whole of the carbonate of ammonia will not be decomposed, and will tend to mitigate the fetor of the special odor of the putrid urine. So far from disinfecting, in this case the sulphate of lime really destroys a deodorizing, or at least a masking agent, ammonia; leaving free — purified as it were, and unadulterated — an odor, the peculiar offensiveness of which is remarkable. Sulphate of iron being substituted for gypsum in this experiment, afforded a somewhat similar result, although the odor obtained was a trifle less insufferable than that of the experiments with sulphate of lime. It should be here mentioned that the odors in question were in

Among the numerous other substances proposed as disinfectants, or for dressing wounds, the following have not afforded satisfactory results:—

Chlorate of Potash, mixed with clay or kaolin (for example, ten parts of chlorate to ninety parts of white clay or fine sand), which was proposed as an absolute disinfectant, neither disinfected nor absorbed the pus of fetid wounds. The mixture would be in any case much more costly than coal-tar and plaster, and certainly less efficacious.

Whites of Eggs, mixed with chalk and applied to wounds previously oiled, succeeded no better than simple cerate.

Powdered Sugar, when employed in layers upon ulcers, forms crusts, beneath which the suppurations accumulate, and hinder the process of healing.

The members of another group of disinfectants are worthy, in various degrees, of consideration.

Among these, charcoal appears in the front rank. Surgeons have long regarded it as one of the best antiseptics known. Confined between pieces of linen, according to the process of Malapert and Pichot, it is more readily applied than when used as powder directly upon wounds; but the mixture of coal-tar and plaster, which disinfects still better, and is more cleanly, is susceptible of a simpler and a more general application.

Coke of Boghead Coal, in powder, as proposed by Moride,[1] like carbon, when employed, comparatively with coal-tar and plaster, alternately upon the same patients, proved to be less efficacious, less convenient, and more disagreeable than the latter.

Mixed Plaster and Charcoal, proposed by Herpin of Metz, irritates the wounds, disinfects badly, and soils everything it touches.

The following substances have long ago acquired a place, each in its own way, in the class of disinfectants.

Tincture of Iodine has been employed as an antiseptic by hospital surgeons since 1823. By modifying the surfaces to which it is applied, it usually improves the appearance of the pus, lessens its acridity, and is, to a certain extent, antagonistic to putrid infections. It disinfects, however, only incompletely, causes severe pain when applied to open wounds, and would be

no instance contaminated with sulphuretted hydrogen — as was ascertained by careful trials. — *F. H. Storer.*

1 In view of the claim of Moride (*Comptes Rendus*, xlix., 242), as well as from its general interest, the following extract from a report made to the British Secretary of War by Lewis Thompson (London *Journal of Gas Lighting, Water Supply, and Sanitary Improvement*, 1856, v. 11), may here be cited: —

Mr. Thompson states that he has instituted a set of experiments having a purely money basis as their exponent. The articles enumerated were each employed until they practically deodorized one uniform quantity of the same mass of putrid sewage, and the money value of the proportions thus used was deduced either from a broker's price-list, or, where this failed to give the requisite information, by special inquiry from a wholesale dealer. The amount of sewage operated upon in each experiment was half a gallon taken from a single tank which had been recently filled out of a large and very offensive ditch or open sewer. Two indications of the progress of the disinfection were had recourse to in these experiments: one with paper dipped in sugar of lead, which gradually ceased to become brown as the deodorizing agent was added in successive portions; the other had reference to the discontinuance of any offensive smell; and the attainment of this last condition was regarded as the termination of each experiment.

By this means he was enabled to draw up the subjoined table, which shows at a glance the comparative cost of executing the same amount of deodorizing work

expensive if used on a large scale; finally, the odor of iodine is neither agreeable nor unattended by inconveniences.

Perchloride of Iron has been used for some twelve years in hospitals as an antiseptic, and as a means of modifying certain wounds, and putrid or sanguineous foci. Without diffusing the disagreeable odor of tincture of iodine, it has, like the latter, the fault of disinfecting badly, of causing much pain, and of acting violently upon the diseased tissues, besides injuring the cloths which are soaked in it, even more than is the case with the coal-tar and plaster.

Both iodine and the salt of iron just mentioned are in fact agents of another order; they have rendered, and do still render important services. They are certainly well worth preserving, but should not be compared with the mixture of coal-tar and plaster.

Nitrate of Lead, Creosote, and other substances which have been proposed at one time or another, have not realized the expectations of their inventors; their price has been too great, their employment required too much care, or their action has not been sufficiently certain, that they could be advantageously used in practice. There is, nevertheless, one of these which deserves special mention, viz., *chlorine.* Ever since Guyton Morveau demonstrated the true action of muriatic acid upon putrefying animal matters, the efficacy of chlorine has been tested in almost innumerable ways. Solutions of chlorine, of "chloride of soda," and of "chloride of lime," have rendered signal services to medicine and in the cause of public health, especially since Labarraque, some thirty years since, indicated an improved method of employing them. But the odor of chlorine, disagreeable in itself, is neither easily borne nor devoid of inconveniences. Wounds, moreover, hardly accommodate themselves to it any better than the sense of smell, whenever somewhat large doses of it are required.

In conclusion, the committee say: "In order to obtain from the process of

with each agent, on the supposition that Boghead charcoal can be had at the rate of $3.00 [= 12s.] per ton.

Table showing the Cost of Purifying one uniform Quality of Feculent Sewage by the several articles mentioned.

Boghead charcoal (coke),	$3.00
Nitric acid,	8.50
Black oxide of manganese,	9.25
Chloride of lime,	10.75
Peat charcoal,	11.00
Subchloride of iron (imperfect),	11.25
Animal charcoal,	16.75
Chloride of manganese (imperfect),	17.50
Bichloride of mercury,	18.00
Impure chloride of zinc in damp powder,	26.00
Chloride of zinc in solution, as patented by Sir Wm. Burnett,	37.00
Sulphate of copper,	39.00

The sulphates of zinc, iron, and alumina; common gypsum; sulphuric, sulphurous, and muriatic acids; peroxide of iron, highly dried clay, litharge, and sawdust, were found imperfect even when very large quantities were employed.

Arsenious acid and creosote, on the contrary, were very active; but the danger of a subsequent evolution of arseniuretted hydrogen in the first case, and the difficulty of diffusing an oily fluid like creosote in the second, seemed to interdict the use of these substances.—*F. H. Storer.*

Corne and Demeaux its proper effect, certain indispensable precautions must be followed. It is evident, from having neglected some of these precautions, that different experimenters have been led to believe that the method is useless. Fine moulding plaster, and not the common article, should be employed. The coal-tar, which is mixed with it in the proportion of two to four parts to a hundred, by triturating or grinding, ought to impart to it a gray tint, without destroying its dry, pulverulent condition. Objects to be disinfected should be rolled in this powder until each point upon their surfaces has been brought in contact with it. Gangrenous or putrid sores should be covered with thick layers of it, by handfuls, several times per day. If one is treating pus, blood, dejections, or the like, enough of the powder should be added to form a paste of the mass, taking care to replace the first layer of powder by another as soon as it no longer absorbs any more.— *Comptes Rendus, et Silliman's Journal.*

NEW DISINFECTANT.

L'Invention (Paris) states that the following composition has the property of instantaneously disinfecting putrefying matter, privy vaults, etc. It is prepared as follows: Sulphate of iron and sulphate of alumina are dissolved in water, the solution being of a strength of fifty-five degrees. This is evaporated for eight or ten hours, in order to obtain a hard and compact cake, which may be transported in sacks to great distances. During the evaporation, eight or ten per cent of lime is mixed with the compound, which is finally run into forms, and dried perfectly in the air. After it is positively ascertained that it contains no moisture, it is reduced to powder, more or less fine, and delivered to the consumer, who may keep it any length of time either in powder or in solution. This disinfectant has no odor, and it may be employed for a great number of hygienic and domestic purposes.

THE ANTISEPTIC QUALITY OF SUGAR.

It is well known that fruits, flesh, etc., may be indefinitely preserved in a syrup of sugar, in honey, or in glycerine. It has been observed that the life of animals which breathe in water is incompatible with the presence therein of even an inconsiderable quantity of sugar. Mondi offers as an explanation the osmatic or diffusive tendency of these bodies, which prevents the life and propagation of animalculæ, or ferment cells, as these organisms swell and even burst in syrupy solutions. The high density of a liquid is accordingly of chief importance in determining its antiseptic properties.

ON THE PRODUCTS OF PUTREFACTION.—BY F. GRACE CALVERT.

Some eighteen months ago, my friend, Mr. J. A. Ransome, surgeon to the Royal Infirmary, Manchester, induced me to make some researches with the view of ascertaining the nature of the products given off from putrid wounds, and more especially in the hope of throwing some light upon the contagion known as hospital gangrene. I fitted up some apparatus to condense the noxious products from such wounds, but the quantity obtained was so small that it was necessary for me to acquire a more general knowledge of the various substances produced during the putrefaction of animal matter, before I could determine the nature of the products from sloughing wounds. I

therefore began a series of experiments, the general results of which I now wish to lay before the society.

Into each of a number of small barrels twenty pounds of meat and fish were introduced; and, to prevent the clotting together of the mass, it was mixed layer by layer with pumice-stone. The top of each barrel was perforated in two places, one hole being for the purpose of admitting air, whilst through the other a tube was passed which reached to the bottom of the barrel. This tube was put in connection with two bottles containing chloride of platinum, and these in their turn connected with an aspirator. By this arrangement air was made to circulate through the casks so as to become charged with the products of putrefaction, and to convey them to the platinum salt. A yellow amorphous precipitate soon appeared, which was collected, washed with water and alcohol, and dried. This precipitate was found to contain C, H, and N; but, what is highly remarkable, sulphur and phosphorus enter into its composition.

I satisfied myself during these researches, which have lasted more than twelve months, that no sulphuretted nor phosphuretted hydrogen was given off; and my researches, as far as they have proceeded, tend to prove that the noxious vapors given off during putrefaction contain the N, S, and Ph of the animal substance, and that these elements are not liberated in the simple form of ammonia and sulphuretted and phosphuretted hydrogen. I also remarked during this investigation that as putrefaction proceeds, different volatile bodies are given off.

Before concluding, I may add, that when the platinum salts are heated in small test tubes they give off vapors, some acid and some alkaline, possessing a most obnoxious and sickening odor, very like the odors of putrefaction; and that at the same time a white crystalline sublimate, which is not chloride of ammonium, is formed.

As I foresee that these researches will occupy several years, I have deemed it my duty in the mean time to lay the above facts before the society. — *Proceedings of the Royal Society.*

THE "COCOA-NUT PEARL."

At a recent meeting of the Boston Society of Natural History, Dr. C. F. Winslow exhibited to the society a specimen of the so-called "cocoa-nut pearl," set in a ring belonging to F. T. Bush, Esq., of Boston. He stated that it came from Singapore; that very few specimens are found; and that they are highly esteemed by the rajahs, and worn as costly gems. Mr. Bush, during a residence of some years in the East, saw but one other, and that was as large as the egg of a Canary bird; but he heard of others as large as a cherry. Their method of growth was unknown, but they are said to be found free in the cavity of the cocoa nut. The specimen having been presented to the society for examination, Dr. John Bacon, at a subsequent meeting, reported on it, as follows: —

The peculiar characters of this gem are most readily described by comparison with those of animal pearls, which it resembles in many respects. It is about one quarter of an inch in diameter, and of a spherical shape. Its surface, evidently a natural one, is smooth, and of a milk-white color, with little lustre. On close examination, the surface appears mottled, and faint undulated markings are seen within. In hardness it much exceeds true pearls, equalling feldspar, or the average hardness of opal. The hardness of pearls

varies to some extent. Several specimens of different species which I had an opportunity to test ranged between calcite and fluor-spar; none were so hard as fluor.

Chemical Composition.—The cocoa-nut pearl consists of carbonate of lime, with a very small proportion of organic matter; so little that it does not blacken nor evolve any odor before the blowpipe. When the carbonate of lime is removed by the slow action of very dilute acids, a transparent substance remains, of great tenuity, showing no structure under the microscope, and incapable of preserving its form. The chemical reactions obtained with it indicate that the organic substance is an albuminous body, and not cellulose, the basis of vegetable tissues in general. Since albuminous substances occur in plants as well as in the animal kingdom, we cannot find, however, that it is of animal origin. True pearls consist of carbonate of lime, with a considerable amount of albuminous animal matter. When decalcified by dilute acids, the organic residue retains the form and structure of the pearl; and in the nacreous pearls, the characteristic iridescence also.

Microscopical Characters.—Thin sections examined under the microscope show that the cocoa-nut pearl is composed of numerous regularly concentric laminæ, adhering pretty firmly together. These layers form groups differing slightly in tint, and near the exterior are often exceedingly thin. The centre is occupied by a semi-transparent mass resembling the surrounding layers. No foreign nucleus was found. The general mass is made up of radiating bands of crystalline fibres, inclined at different angles in contiguous bands. In the outer layers, the crystalline structure becomes strongly marked with rhombohedral cleavage. Probably the great hardness of this pearl depends upon the peculiar crystalline arrangement, with a little organic matter binding the whole firmly together.

Pearls exhibit two principal varieties of microscopic structure. The true or nacreous pearl is formed of concentric laminæ of nacre, and shows a finely furrowed surface, and no radiating lines within. The markings of the nacreous membrane, by which iridescence is produced, are faintly visible in the sections as very fine undulated and dotted lines. In the second variety of pearl, a prismatic cellular structure occurs. These pearls exhibit well-marked radiating lines, as well as concentric layers. In many specimens of pearl, both varieties of structure are found. The cocoa-nut pearl presents a general resemblance in microscopic characters to the second variety, but differs essentially in the details of structure, as is evident from the sections now exhibited of pearls from pearl oysters and from fresh-water clams,—showing the nacreous and prismatic varieties, and combinations of both.

I cannot find that any species of pearl or other concretion resembling this has been described. Nor could I learn from our best botanical authorities that any concretion is known to occur in the cocoa nut. The milk of this nut contains, according to the reported analyses, a little phosphate and malate of lime, but no carbonate; nor is the carbonate found in any part of the nut. Possibly an analysis of the immature nut might give a different result. The only concretions of vegetable origin which approach this in composition and structure are the cystolithes found in the leaves of Urticaceæ, and some other families of plants. These are minute bodies, showing concentric lamination. But they consist of a matrix of successive layers of cellulose, upon which crystalline masses of carbonate of lime are deposited in a kind of efflorescence; a wholly different mode of formation.

In the animal kingdom, several kinds of concretions besides pearls bear

more or less resemblance to this body in composition and structure; especially the concretions of carbonate of lime formed in the bladders of herbivorous animals, in which more or less animal matter is always combined with the salt of lime. Numerous concentric layers and a radiated crystalline structure are frequently visible. The organic matter is usually in small proportion, though often sufficient to preserve the original form and structure when the carbonate of lime is removed by acids; occasionally there is more animal matter than in true pearls.

It is to be regretted that the origin of the cocoa-nut pearl is not certainly known, since neither the chemical nor microscopic characters are sufficient to point out its source and mode of formation. Were the statement of its origin perfectly reliable, it might be regarded as the product of a diseased condition of the nut. The concentric lamination might seem to require a longer time than the rapid growth of the cocoa nut would admit of; but in the case of animal calculi of similar chemical composition, and of such as can be made artificially, these layers, whether resulting from successive depositions or from a process of segregation, may be rapidly formed. A few weeks, and sometimes only a few hours, are sufficient for the production of numerous laminæ.

CELLULOSE DIGESTED BY SHEEP.

The researches of several German chemists have proved that the cellulose of plants is by no means so indigestible a substance as was at one time supposed; but that, on the contrary, it is digested in considerable quantities, by the ruminants at least, especially when a portion of the food of the animal consists of some substance rich in oil. In order to ascertain to what extent the digestibility of cellulose may depend upon its state of aggregation, Sussdorf and A. Stœckhardt have undertaken a series of experiments, of which only a very brief abstract can be here given. From their results it is evident, that even the most compact kinds of cellulose can be in a great measure digested by sheep. The experiments, commenced in July, 1859, were upon two wethers, respectively five and six years old. These were fed: first, upon hay alone; second, upon hay and rye straw; third, hay and poplar-wood sawdust which had been exhausted with lye—in order that the sheep should eat the sawdust, it was found necessary to add to it some rye-bran and a small quantity of salt; fourth, hay and sawdust from pine wood mixed with bran and salt; fifth, hay, spruce sawdust, bran and salt; sixth, hay, paper-makers' pulp from linen rags and bran. After several unsuccessful attempts to induce the sheep to partake of the pulp when mixed with dry fodder, it was at last given to them in a sort of paste or pap, prepared by mixing bran with water. The experiments were continued until November, with the exception of a short intermission during which the animals were put to pasture, in order that they might recover from the injurious effects—probably due to the resinous matters of the spruce-wood—of the fifth series of experiments. The animals, as well as their food, drink and excrements, were weighed every day. The amount of cellulose in the excrements was also daily determined by analysis; the composition of the food ingested having been previously ascertained. It appeared that where the animals were fed, first, with hay (thirty-five pounds per week), sixty to seventy per cent of the cellulose contained therein was digested, *i. e.*, it did not appear as such in the solid excrements. In this experiment the animals gained seven and a half pounds in

eighteen days. Second, with hay fourteen pounds, and straw seven pounds (per week), forty to fifty per cent of the cellulose of the straw was digested; the animals having lost two and a half pounds in eleven days. Third, with hay ten and a half pounds, poplar sawdust five and a quarter pounds, bran seven pounds (per week), forty-five to fifty per cent of the cellulose of the poplar-wood was digested; the animals having gained two and a half pounds in thirteen days. Fourth, with hay ten and a half pounds, pine-wood sawdust seven pounds, bran ten and a half pounds (per week), thirty to forty per cent of the cellulose of the pine-wood was digested; the animals having gained ten pounds in twenty-four days. Fifth, with hay nine and a half pounds, paper-makers' pulp seven pounds, bran fourteen pounds (per week), eighty per cent of the cellulose of the paper pulp was digested; the animals having gained seven pounds in as many days.

These experiments are to be continued, and more particularly with a view of ascertaining whether any nourishing effect is to be attributed to the cellulose.—*Stœckhardt's Chemischer Ackersman*, 1860, No. 1, p. 51.

CHITINE.

M. Peligot, describing some investigations on the chemistry of the skin of the silk-worm in the *Annales de Chimie et de Physique*, states the discovery of cellulose in the chitine which it contains. He obtained similar results from the chitine of the lobster, and thinks it probable that chitine is never a single substance, but a mixture of two substances, one non-nitrogenous cellulose and the other nitrogenous, belonging to the class of albumenoid or protein compounds. He says that a mixture of two parts of protein and one of cellulose would have the composition which he considers to belong to the skin of silk-worms. Cellulose is the proximate principle of which the vegetable cell membranes of plants is composed, and, according to the *Micrographic Dictionary*, is found in the mantle of the *Tunicata*. Should M. Peligot's views be found correct, the relations between the animal and vegetable kingdoms will appear stronger, as chitine is the horny substance which gives firmness to the shells and skins of the crustaceans, spiders, and insects. M. Peligot thus sums up the philosophy of his researches: "The exterior envelop of animals and plants, whether it be more or less resisting, is composed of two substances, cellulose and protein,—cellulose, which exists in vegetables and the inferior animals; cellulose and protein, which exist in animals of a higher organization; and of protein alone, which forms the tissues of the vertebrate class."

ON THE PRESENCE OF ARSENIC IN PLANTS USED FOR FOOD.

It will be recollected that Professor Davy, of Dublin, last year reported the results of some experiments which went to show that some plants might with impunity be watered even with a saturated aqueous solution of arsenious acid; that the plants took up this arsenic and accumulated it in their tissues, to such an extent that traces of this metal were discoverable in the bodies of animals fed upon vegetables so treated. These astonishing results naturally excited inquiry. They have now been contradicted in a late number of the *Pharmaceutical Journal*, by Mr. Ogston, an analytical and agricultural chemist, formerly a pupil of Professor Graham. Mr. Ogston finds that, on watering the ground around the roots of some vigorous cabbage-plants, some months

old, with a saturated solution of arsenious acids, in every trial, after two doses at intervals of three days, the plants died within the week. The same occurred with Scotch kale, the only other plant subjected to the experiment. On testing the dead plants arsenic was detected only in the portion of the stem close to the roots, and which showed in its darkened color the marks of disease. In no case was any of the poison found in the leaves, or in the stem at more than five inches above the ground. Professor Davy also startled the English agriculturists and medical jurists by calling attention to the fact that arsenic exists in the commercial superphosphate of lime, at least in certain kinds, coming from the iron-pyrites used in the manufacture of the sulphuric acid employed in the production of the superphosphate, which arsenic, if plants may accumulate it in their tissues, would be conveyed to the flesh of animals fed with turnips manured with such superphosphate, and so conveyed to the human system,—if not in quantity sufficient to poison, yet enough to account for the presence of arsenic in cases of death from supposed poisoning. Mr. Ogston now considers the question as to how much arsenic an agricultural crop (say of turnips) can obtain from an ordinary dressing of the superphosphate so prepared. "Take a very bad sample of pyrites said to contain .30 per cent of arsenic, and consider, as is the case, that in the manufacture of oil of vitriol one-half of this is stopped by condensation in the flues; .15 per cent will remain in relation to the pyrites, or about .10 in relation to the manufactured oil of vitriol. Now, suppose the superphosphate made from this acid to contain twenty per cent. of it as a constituent, and that three hundredweight are used as a dressing per acre, there will be added to this acre .07 of a pound of arsenic, and this is to be distributed among from twenty to twenty-five tons of roots, giving a percentage infinitely small, and in my opinion relieving us from the necessity of the smallest anxiety on the subject.

ON FERMENTED BREAD.

It is well known to our readers that, some two years ago, a new plan of preparing bread was devised by Dr. Dauglesh, of Scotland;[1] in which, in the place of generating carbonic acid within the substance of the dough by fermentation, water charged with carbonic acid (common "soda water") was mixed under pressure with the flour, effecting thereby a raising of the bread by mechanical means, imparting to it a most perfect vesicular structure, and leaving the constituents of the flour wholly unchanged. An objection having, however, been made by some medical authorities to the process (which has been experimentally introduced in Great Britain), that the constituents of flour, especially the starch, are not fit for human food until they have been subjected to fermentative action, Dr. Dauglesh, in a late number of the *London Medical Times and Gazette*, combats the objection in the following article, which our readers will find replete with valuable and interesting information. He says:—

In order to dispose of the assertion that starch requires to be prepared by the fermentive changes to render it fit for human food, it is but necessary to remark, that the proportion which the inhabitants of the earth who thus prepare their starchy food bear to those who do not is quite insignificant. Indeed, it would appear that the practice of fermenting the flour or meal of

1 See Annual of Scientific Discovery for 1859, p. 275.

the cereal grains is followed chiefly by those nations who use a mixed animal and vegetable diet, while those who are fed wholly on the products of the vegetable kingdom reject the process of fermentation entirely. Thus, the millions of India and China, who feed chiefly on rice, take it, for the most part, simply boiled; and that large portion of the human race who feed on maize, prepare it in many ways, but they never ferment it. The same is true with the potato-eater of Ireland, and the oatmeal-eater of Scotland. Nor do we find that even wheat is always subjected to fermentation; but the peculiar physical properties of this grain appear to have tasked man's ingenuity more than any other, to devise methods of preparing from it food which shall be both palatable and digestible. In the less civilized states, a favorite mode of dressing wheat grain has been, by first roasting and then grinding it. On the borders of the Mediterranean it is prepared in the form of maccaroni and vermicelli, while in the East it is made into hard thin cakes for the more delicate, and for the hard-working and robust into thicker and more dense masses of baked flour and water. Even in our own nurseries, wheaten flour is baked before it is prepared with milk for infants' food. The necessity of subjecting wheaten grain to these manipulations arises from its richness in gluten, and from the peculiar properties of that gluten. If a few wheaten grains are taken whole and thoroughly masticated, the starchy portion will be easily separated, mixed with the saliva, and swallowed, whilst nearly the whole of the gluten will remain in the mouth, in the form of a tough, tenacious pellet, on which scarcely any impression can be made. A similar state of things will follow the mastication of flour. In this condition, the gluten is extremely indigestible, since it cannot be penetrated by the digestive solvents, and they can only act upon its small external surface; hence the necessity to prepare food from wheat in such a manner as shall counteract this tendency to cohere and form tenacious masses. This is the object of baking the grain and flour as before mentioned, of making it into maccaroni, and of raising it into soft, spongy bread; by which latter means the gluten assumes a form somewhat analogous to the texture of the lungs, so that an enormous surface is secured for the action of the digestive juices; and this, I believe, is the sole object to be sought in the preparation of bread from wheaten flour.

Wheat is said to be the type of adult human food. It supplies, in just proportions, every element essential to the perfect nutrition of the human organism. And yet, in practice, we find that the food which we prepare from it, and furnish to the inhabitants of our large towns and cities, is quite incapable alone of sustaining the health and strength of any individual. This is the more remarkable, since in Scotland we find that the food prepared from the oat, a grain possessing the same elements of nutrition as wheat, though in a coarser form, furnishes almost the exclusive diet of a very large number of the hardiest and finest portion of the population.

In the large towns of France wheaten bread certainly forms a very large proportion of the diet of the laboring classes, but not so large as oatmeal does in Scotland. And yet it has been remarked by contractors for public works on the continent, that the chief reason why the Englishman is capable of accomplishing double the work of a Frenchman is, that the one consumes a very large proportion of meat, while the diet of the other is chiefly bread. In Scotland, however, the laboring man is capable of sustaining immense fatigue upon the nourishment afforded by oatmeal porridge.

The deficiency in wheaten bread in affording the nourishment due to the

constituents of the grain, is to be attributed solely to the mode of preparing the flour, and the process followed for making that flour into porous bread.

The great object sought after, both by the miller and the baker, is the production of a white and light loaf. Experience has taught the miller that the flour which makes the whitest loaf is obtained from the centre of the grain; but that the flour which is the most economical, and contains the largest portion of sound gluten, is that which is obtained from the external portion of the grain. But while he endeavors to secure both these portions for his flour, he takes the greatest care to avoid, as much as possible, by fine dressing, etc., the mixture with them of any part of the true external coat which forms the bran, knowing that it will cause a most serious deficiency in the color of the bread after fermentation.

It is generally supposed that the dark color of brown bread — that is, of bread made from the whole wheaten meal — is attributable to the colored particles of the husk or outer covering of the grain. But such is not really the case. The colored particles of the bran are of themselves only capable of imparting a somewhat orange color to bread, which is shown to be the fact when whole wheaten meal is made into bread by a process where no fermentation or any chemical changes whatever are allowed to take place. Some few years since, a process was invented in America for removing the outer seed coat of the wheat grain without injuring the grain itself, by which it was proposed to save that highly nutritious portion which is torn away, adhering to the bran in the ordinary process of grinding, and lost to human consumption. The invention was brought under the notice of the French Emperor, who caused some experiments to be made in one of the government bakeries to test its value. The experiments were perfectly satisfactory so far as the making of an extra quantity of white flour was concerned; but when this flour was subjected to the ordinary process of fermentation, and made into bread, much to the astonishment of the parties conducting the experiments, and of the inventor himself, the bread was brown instead of white. The consequence, of course, has been that the invention has never been brought into practical operation.

It has been estimated that as much as ten or twelve per cent of nutritious matter is separated, adhering to the bran which is torn away in the process of grinding; and until very lately this matter has been considered by chemists to be gluten. It has, however, been shown by M. Mouriès to be chiefly a vegetable ferment, or metamorphic nitrogeneous body, which he has named Cerealin, and another body, vegetable caseine.

Cerealin is soluble in water, and insoluble in alcohol. It may be obtained by washing bran, as procured from the miller, with cold water, in which it dissolves, and it may be precipitated from the aqueous solution by means of alcohol; but, like pepsin, when thus precipitated it loses its activity as a solvent or ferment. In its native state, or in aqueous solution, it acts as the most energetic ferment on starch, dextrine, and glucose, producing the lactic and even the butyric changes, but not the alcoholic. It acts remarkably on gluten, especially when in presence of starch, dextrine, or glucose. The gluten is slightly decomposed at first, giving ammonia, a brown matter, and another production which causes the lactic acid change to take place in the starch and glucose. The lactic acid thus produced immediately combines its activity with that of the cerealin, and the gluten is rapidly reduced to solution. The activity of the cerealin is destroyed at a temperature of one hundred and forty degrees Fahrenheit, according to M. Mouriès; but my own experi-

ments show that it is simply suspended even by the heat required to cook bread thoroughly. Thus, bread made without fermentation, of whole wheaten meal, or of flour in which there is a large proportion of cerealin, will, if kept at a temperature of about seventy-five to eighty-five degrees Fahrenheit, pass rapidly into a state of solution, if the smallest exciting cause be present, such as ptyaline or pepsin, or even that small amount of organic matter which is found in impure water; while the same material, when it has been subjected to the alcoholic fermentation, will not be affected in a like manner.

The activity of cerealin is very easily destroyed by most acids, also by the presence of alum; and while it is the most active agent known in producing the earlier changes in the constituents of the flour, it cannot produce the alcoholic; but as soon as the alcoholic is superinduced, the cerealin becomes neutralized and ceases to act any longer as a solvent. M. Mouriès, taking advantage of this effect of alcoholic fermentation, has adopted a process by which he is enabled to separate from the bran all the cerealin and caseine which are attached to it. He subjects the bran to active alcoholic fermentation, which neutralizes the activity of the cerealin, and at the same time separates the nutritious matter; and then, having strained this through a fine sieve, he adds it to the white flour in the preparation of white bread, by which an economy of ten per cent is effected, and the color of the bread is not injured.

The peculiar action of cerealin as a special digestive solvent of the constituents of the flour — gluten and starch — has been practically tested by Mr. Darby in a series of careful experiments. He found that when two grains of dry cerealin were added to five hundred grains of white flour, and the whole digested in half an ounce of water at a temperature of ninety degrees for several hours, ten per cent more of the gluten, and about five per cent more of the starch, were dissolved than when the same quantity of flour was subjected to digestion without the addition of cerealin; but in which, of course, there was a small amount of cerealin that is present in all flours. The action of cerealin upon the gluten of wheat is precisely similar to that of pepsin on the fibrine of meat. Pepsin, acting alone on fibrine, dissolves it, but very slowly; but if lactic acid be added, solution takes place very rapidly. In like manner, the starch present with the gluten of wheat is acted upon by the cerealin, and produces the necessary lactic acid to assist in the solution of the gluten by cerealin.

With the knowledge thus obtained of the properties of this substance, cerealin, it is not difficult to understand why the administration of bran-tea, with the food of badly-nourished children, produces the remarkable results attributed to it by men both experienced and eminent in the medical profession; and why, also, bread made from whole wheaten-meal, which contains all the cerealin of the grain, should prove so beneficial in some forms of mal-assimilation, notwithstanding the presence of the peculiarly indigestible and irritating substance forming the outer covering of the grain.

It will be seen that in all the methods of bread-making hitherto adopted, the peculiar solvent properties of this body, cerealin, have been sought to be neutralized simply because it destroys the white color of the bread during the early stages of panary fermentation. It is by thus destroying the activity of the special digestive ferment which nature has supplied for the due assimilation by the economy of the constituents of the wheaten grain, that wheaten bread is rendered incapable of affording that sustenance to the laboring man which the Scotchman obtains from his oatmeal porridge.

Although the new bread has been as yet but little more than experimentally introduced to public consumption, I have already received from members of my own profession, who have recommended it in their practice, as well as from non-professional persons, accounts of the really astonishing results that have followed its use in cases of deranged digestion and assimilation. Private gentlemen have sought interviews with me to record the history of their recovery to health, after years of suffering and misery, by the simple use of the bread as a diet. And cases are now numerous that have been communicated to me by medical men of position, in which certain distressing forms of dyspepsia, which had remained intractable under every kind of treatment, have yielded as if by magic almost immediately after adopting the use of the aërated bread.

I am disposed to attribute the beneficial effects of the new bread to two causes. The one to the *absence* of the prejudicial matters imparted to ordinary bread by the process of fermentation; and the other to the *presence* in the bread, unchanged, of that most essential agent of digestion and assimilation, cerealin.

I believe the prejudicial matters imparted to bread by fermentation to be chiefly two, — acetic acid and the yeast-plant. The first is produced in large quantities, especially in hot weather, by the oxydation, by atmospheric contact, of the alcohol produced. The second is added when the baker forms his sponge, and is also rapidly propagated during the alcoholic fermentation, and cannot of course be afterwards separated from the other materials in the manner that the yeast and other *débris* of fermentation separate themselves from wine and beer by precipitation in the process of fining. Nor is the life of the yeast-plant generally destroyed in baking, because it requires to be retained at the boiling point for some time before it is thoroughly destroyed; and bread is generally withdrawn from the oven, for economical reasons, even before the centre of the loaf has reached the temperature of two hundred and twelve degrees. It is not difficult to understand how the most painful and distressing symptoms and derangements may follow the use of bread in which the yeast-plant is not thoroughly destroyed previous to ingestion, and in those cases of impaired function in which the peculiar antiseptic influence of the stomachal secretions is deficient, and is incapable of preventing the development of the yeast-plant in the stomach, and the setting up of the alcoholic fermentation to derange the whole process of digestion and assimilation.

The presence of cerealin in bread is as beneficial as that of acetic acid and the yeast-plant is prejudicial. Digestion, or the reduction of food, is evidently essentially dependent on the action of a class of substances which chemists, for want of a better term, have called ferments; to these substances belong pepsin, ptyaline, emulsin, diastase, and cerealin. These are evidently types of a very numerous class, which act by producing those molecular changes in organic substances in which digestion consists; and since the purpose of digestion, or solution, is to prepare from heterogeneous substances taken as food a chyle, which shall not only when absorbed present all the elements of healthy blood, but shall, previous to absorption, possess the properties which will constitute it the proper stimulus to the functional activity of the lacteals, it would appear to be necessary that each distinct substance taken as food should be furnished, not with its simple chemical solvent, but with that peculiar form of solvent, or ferment, which alone can carry it through those molecular changes which shall terminate in the production of healthy chyle.

Hence we should infer that a substance was digestible or indigestible just in proportion to the provision that is made for its reduction to the standard of healthy chyle; and that substances which have hitherto been incapable of affording any nutrition whatever may at some future day be rendered highly nutritious, simply by adding to them suitable ferments, artificially obtained or otherwise, that shall secure their passage through the proper molecular changes. Indeed, I think this subject opens to us that very wide field of inquiry, as to whether the cause and prevention of disease, and the beneficial administration of remedies, may not, for the most part, if not entirely, be dependent on the action of substances analogous to such bodies as ptyaline, pepsin, cerealin, etc., acting in concord with, or retarding and opposing, the vital functions of tissues; and that, by more profound inquiry in this field of research, the physiologist and the pathologist may not at a future day lay the foundation of true scientific medicine.

PRESERVATION OF FLESH BY VERDEIL.

Having been separated from the bones, and, as far as possible, from fat, the flesh is cut into slices from one to five centimetres (one centimetre = 0·3937 inch) in thickness; the slices being cut as nearly as possible across the grain of the flesh. These are now laid upon hurdles of basket-work, which are subsequently placed in a chamber. As soon as a sufficient number of the trays have been introduced into the chamber, it is closed, and steam, under a pressure of three or four atmospheres, consequently of 135° to 145° C. (= 275° to 293° F.), is admitted through several openings. The chamber, which may be of lead or iron, must not be absolutely tight, a small outlet for the steam being necessary, in order that the pressure may not become too great. After from six to ten or fifteen minutes, according to the kind of flesh and the thickness of the slices, the steam is shut off, this part of the process being finished. The flesh is now very nearly in the condition of boiled meat, but has retained all of its ingredients, the albumen having been coagulated, its taste recalling that of roasted meat. It presents a wrinkled appearance, is of a gray color, and may be readily divided. Being removed from the steam-chamber, the flesh is now placed upon trays, or hung upon hooks, in another chamber, which is warmed, but in which the temperature is never allowed to exceed 40° or 50° C. (= 104° to 122° F.). The drying process is completed in the course or eight or twelve hours.

Packed in tight casks or in tin boxes, so that it may be protected from the action of moisture and from insects, the flesh thus prepared may be preserved for any length of time which may be desirable. It is, nevertheless, well to place a layer of salt in the casks, in order that it shall absorb any moisture which the flesh may have retained. Before using this meat it must be soaked for an hour or two in warm water, in which it softens and regains its original condition. When boiled with water it affords an excellent soup, and passes into a condition in which it cannot be distinguished from fresh meat. — *Le Génie Industriel.*

INQUIRIES INTO THE PHENOMENA OF RESPIRATION.

In a communication to the *L. E. and D. Philosophical Journal*, Jan., 1860, Dr. Edward Smith gives the result of numerous inquiries into the quantity of carbonic acid expired, and of air inspired, with the rate of pulsation and

respiration, — 1st, in the whole of the twenty-four hours, with and without exertion and food; 2d, the variations from day to day, and from season to season; and, 3d, the influence of some kinds of exertion.

After a description of the apparatus employed by previous observers, he describes his own apparatus and method. This consists of a spirometer to measure the air inspired, capable of registering any number of cubic inches, and an analytical apparatus to abstract the carbonic acid and vapor from the expired air. The former is a small, dry gasmeter, of improved manufacture, and the latter consists of, — 1st, a desiccator of sulphuric acid to absorb the vapor; 2d, a gutta-percha box, with chambers and cells, containing caustic potash, and offering a superficies of 700 inches, over which the expired air is passed, and by which the carbonic acid is abstracted; and, 3d, a second desiccator to retain the vapor which the expired air had carried off from the potash box. A small mask is worn, so as to prevent any air entering the lungs without first passing through the spirometer, and the increase in the weight of this with the connecting tube and the first desiccator gives the amount of vapor exhaled, whilst the addition to the weight of the potash box and the second desiccator gives the weight of the carbonic acid expired. The balances employed weigh to the one-hundredth of a grain, with seven pounds in the pan. By this apparatus the whole of the carbonic acid was abstracted during the act of expiration, and the experiment could be repeated every few minutes, or continued for any number of hours, and be made whilst sleeping and with certain kinds of exertion.

The amount of carbonic acid expired in the twenty-four hours was determined by several sets of experiments. Four of these, consisting of eight experiments, were made upon four gentlemen: on the author, Professor Frankland, F. R. S., Dr. Murie, and Mr. Moul, during the eighteen hours of the working day. In two of them, the whole of the carbonic acid was collected, and in two others the experiment was made during ten minutes, at the commencement of each hour, and of each hour after the meals. The quantity of carbonic acid varied from an average of 24.274 ounces in the author to 16.43 ounces in Professor Frankland. The quantity evolved in light sleep was 4.88 and 4.99 grains per minute, and scarcely awake, 5.7, 5.94, and 6.1 grains at different times of the night. The author estimates the amount in profound sleep at 4.5 grains per minute; and the whole evolved in the six hours of the night at 1950 grains. Hence the total quantity of carbon evolved in the twenty-four hours, at rest, was, in the author, 7.144 ounces. The effect of walking at various speeds is then given, with an estimate of the amount of exertion made by different classes of the community, and of the carbon which would be evolved with that exertion.

The author then states the quantity of air inspired in the working day, which varied from 583 cubic inches per minute in himself to 365 cubic inches per minute in Professor Frankland; the rate of respiration, which varied in different seasons as well as in different persons; the depth of inspiration, from 30 cubic inches to 39.5 cubic inches; and the rate of pulsation. The respirations were to the pulsations as 1 to 4.63 in the youngest, and as 1 to 5.72 in the oldest. One-half of the product of the respirations into the pulsations gave nearly the number of cubic inches of air inspired in some of the persons, and the proportion of the carbonic acid to the air inspired varied from as 1 grain to 54.7 cubic inches to as 1 grain to 58 cubic inches. The variations in the carbonic acid evolved in the working day gave an average maximum of 10.43 and a minimum of 6.74 grains per minute. The

quantity increased after a meal and decreased from each meal, so that the minima were nearly the same, and the maxima were the greatest after breakfast and tea.

The effect of a fast of forty hours, with only a breakfast meal, was to reduce the amount of carbonic acid to seventy-five per cent of that which was found with food, to render the quantity nearly uniform throughout the day, with a little increase at the hours when food had usually been taken, and to cause the secretions to become alkaline.[1]

The variations from day to day were shown to be connected with the relation of waste and supply on the previous day and night; so that, with good health, good night's rest, and sufficient food, the amount of respiration was considerable on the following morning, whilst the reverse occurred with the contrary conditions. Hence the quantities were unusually large on Monday. Temperature was an ever-acting cause of variation, and caused a diminution in the carbonic acid as the temperature rose.

The effect of season was to cause a diminution of all the respiratory phenomena as the hot season advanced. The maximum state was in spring, and the minimum at the end of summer, with periods of decrease in June and of increase in October. The diminution in the author was thirty per cent in the quantity of air, thirty-two per cent in the rate of respiration, and seventeen per cent in the carbonic acid. The influence of temperature was considered in relation to season, and it was shown that whilst sudden changes of temperature cause immediate variation in the quantity of carbonic acid, a medium degree of temperature, as of 60°, is accompanied by all the variations in the quantity of carbonic acid, and that there is no relation between any given temperature and quantity of carbonic acid at different seasons. Whatever was the degree of temperature, the quantity of carbonic acid, and all other phenomena of respiration, fell from the beginning of June to the beginning of September. The author then described the influence of atmospheric pressure, and stated that neither temperature nor atmospheric pressure accounts for the seasonal changes.

The kinds of exertion which had been investigated were walking and the treadwheel. Walking at two miles per hour induced an exhalation of 18.1 grains of carbonic acid per minute, and at three miles per hour, of 25.83 grains; whilst the effect of the treadwheel, at Coldbath Fields Prison, was to increase the quantity to 48 grains per minute. All these quantities vary with the season; and hence the author recommends the adoption of relative quantities, the comparison being with the state of the system at rest, and apart from the influence of food.

APPLICATION OF THE PHYSICAL SCIENCES TO MEDICINE.

A discussion which has recently taken place in the French Academy of Medicine, on the action of iron used as a medicine, has made known to us this unexpected fact, that there are physicians who deny any influence exercised by medicines in virtue of their chemical properties, and who think that the physical and chemical actions of the animal economy differ entirely from those which are observed in the vegetable kingdom.

1 The quantity of air was reduced thirty per cent, that of vapor in the expired air fifty per cent, the rate of respiration was reduced seven per cent, and of pulsation six per cent.

At the head of this retrograde school (which ignores the progress made by physics and chemistry in the last eighty years, and to whom organized beings are composed of a material which is not subject to the general laws of matter which composes the universe) appears a physician celebrated more than the rest, Dr. Trousseau, who, raising the banner of vitalism, has declared that chemical laws explain nothing when used in relation to man, and that medicinal agents act by unknown and very different means from those which chemists suppose. Space does not allow us to notice the reply made at the same sitting by another physician, Poggiale, who is also somewhat of a chemist. But we shall be asked, What is the precise meaning of vitalism? Vitalism is a force in the category of what has been called catalytic force: this is a word which conceals our ignorance, and which is evidently an obstacle to progress. This recalls that saying of Liebig: "If we allow force to be created, investigations become useless, and it will be impossible to arrive at the knowledge of truth." Vital force is, then, entirely for those physicians who ignore the first notions of physics or chemistry, and think all has been said when they have installed this senseless word in place of an organic fact which ranks under the laws of mechanics, physics, or chemistry. Vital force is insufficient to explain how it happens that a large number of substances, such as sugar, tartaric and malic acids, sulphur, sulphurets, salicine, etc., etc., undergo in the animal economy the same changes as when subjected to chemical action.

When we remember that slight compression of a muscle suffices to develop heat, and that its contraction evolves electricity; that in order to establish chemical action it suffices to place two heterogeneous bodies in contact, one is surprised that medical men should seek to explain the phenomena of life by "vital force;" as if the material of our bodies was exempted from the laws that regulate matter; as if what they call vital laws could interfere with the play of physical, mechanical, or chemical laws. — *Silliman's Journal.*

ANÆSTHETIC ACTION OF CHLOROFORM.

Dr. Piossek has presented to the Physiological Society of Greisswald an account of experiments with chloroform, made under the direction of Professor Hunefeld, which seem to establish the following conclusions as to the *modus operandi* of chloroform beyond a doubt: —

Chloroform produces anæsthesia by abstracting from the blood some of the oxygen necessary to the continuance of the organic processes, thus causing impaired nutrition of the central organs and nerves; hence the insensibility of the sensatory, and the relaxation of the motory, nerves. The oxygen of the blood probably combines with the carbon (liberated by the decomposition of the chloroform) to form carbonic acid; while the chlorine and water of the chloroform probably form hydrochloric acid, etc. Into what combination this hydrochloric acid may then enter with the ingredients of the blood, is as yet unknown. The other anæsthetics, ether, amylene, etc., act similarly, and their *modus operandi* may be compared to the narcotizing or asphyxiating action of carbonic acid or nitrous oxide.

COMMERCIAL CHLORIC ETHER.

It is a source of some inconvenience to apothecaries to know what is intended by the physician when "chloric ether" is prescribed. On turning

to the United States *Dispensatory*, it informs us that a mixture of one part of chloroform and two parts of nearly absolute alcohol is called "strong chloric ether," and is used for inhalation; and that in London, and elsewhere, a weak tincture of chloroform is sold under the name of chloric ether, varying in strength from five or six to sixteen or eighteen per cent. Dr. Thompson originally gave the name of "chloric ether" to the Dutch liquid ($C_4\,H_4\,Cl_2$). In the commerce of this country there is a preparation that goes by the name of chloric ether, consisting wholly or chiefly of chloroform and alcohol, which, when mixed with water, does not separate. On inquiring of Mr. William Weightman (of Powers and Weightman) what the article prepared by them under this name was, he stated that their firm had prepared it as they sold it for more than twenty-five years, since soon after Mr. Guthrie's discovery of chloroform, which he called chloric ether. The preparation sold by them is obtained by distilling together chloride of lime, alcohol, and water, in the proportion of eight pounds *av.* of chloride of lime to a gallon of alcohol and a suitable quantity of water, and distilling a gallon of the "chloric ether." As chloride of lime, on the average, yields from six to eight per cent of chloroform, it is fair to infer that this preparation does not contain more than eight per cent of that substance. It has the following properties: It is colorless, has an agreeable, weak odor of chloroform, a sweet, spicy taste of chloroform, with a cooling after-impression, somewhat like that of peppermint. Its specific gravity is .892. When mixed with water, in the proportion of one to twenty, it is at first cloudy, and almost instantly becomes clear, with but little, if any, separation of chloroform. It is this latter property that has caused it to be preferred by some practitioners. That the proportion of chloroform in this preparation varies is quite certain, as Mr. Weightman states that it is not always of such composition as to mix with water without precipitation. It is quite inflammable, and burns with a yellowish flame, tinged with bluish green. When two fluid drachms of chloroform and fifteen fluid drachms of alcohol (ninety-five per cent) are mixed, the mixture has a specific gravity approximating closely to that of the above "chloric ether." Such a mixture contains about sixteen per cent of chloroform, and when added to water is instantly precipitated. Whether the specific gravity of the commercial article is due partly to water, or whether the chloroform is so intimately combined with the alcohol in the process of making as to render the mixture stable in the presence of water, has not been determined; but there is a marked difference in the behavior of the liquids with an excess of water.—*William Procter, Jr., American Journal of Pharmacy.*

EFFECTS OF CARBONIC ACID ON THE SKIN.

According to a paper recently presented to the French Academy, on the above subject, one of the most singular properties of carbonic acid is its decided effect upon the skin. All parts of the body that come in contact with it feel immediately an extraordinary increase of heat which is not exhibited by the thermometer. A person placed in a room heated to twenty degrees Centigrade, and plunging his naked arm into a receiver full of carbonic acid gas, feels as though he had put his arm into something fifteen or twenty degrees hotter than the air of the chamber. This property has been turned to account medically in thermal establishments where baths and douches of the gas, sometimes pure and sometimes mixed, have been

administered to invalids, with what effect is not stated. M. Boussingault says that in a trench of an old sulphur-mine in New Granada he was almost suffocated and thrown into a violent perspiration by this gas, the heat of which he believed, at the time, to be equal to forty degrees; but his thermometer, after being left an hour in the trench, only marked nineteen degrees, — three degrees, in fact, less than the temperature of the surface in the shade. The professor also felt a pricking sensation in the eyes from the effect of the gas, and he was assured by the miners that they almost all suffered from weakness and blindness.

ANTIDOTE FOR PHOSPHORUS.

Poisoning by phosphorus is becoming common from the facility of procuring friction matches. It is, therefore, important that the antidote which has of late been found the most effacious should be extensively known.

Messrs. Antonielli and Barsorelli have shown by numerous experiments on animals :

1st. That fatty matters should not be employed in poisoning by phosphorus, as these matters, far from preventing its action on the viscera, on the contrary increase its energy, and facilitate its diffusion through the economy. 2d. That calcined magnesia, suspended in boiled water, and administered largely, is the best antidote, and, at the same time, the most appropriate purgative to facilitate the elimination of the toxic agent. 3d. That the acetate of potash is extremely useful when there is dysuria in poisoning with phosphorus. 4th. That the mucilaginous drinks which are given to the patient should always be prepared with *boiled* water, so that those beverages may contain as little air as possible.

LIEBIG'S ARTIFICIAL TARTARIC ACID.

The identity of the tartaric acid prepared artificially, *i. e.*, not from its compounds, but out of its components, by Professor Liebig, has been further confirmed by the optical relations of the acid as regards the polarization of light.

This discovery is likely to throw considerable light upon certain processes or the relations of certain products of vegetable life. Thus we see that unripe grapes contain tartaric acid, which gradually disappears, and in its place we find the mature grape to contain sugar, a carbo-hydrate; and since tartaric acid is now prepared from carbo-hydrates, it may be presumed with great probability that by the reverse procedure the plant converts the acid into sugar. Liebig considers tartaric acid in its primary composition to be oxalic acid partly converted into a carbo-hydrate or paired with a carbo-hydrate. There are undoubtedly similar relations between *malic* and *citric acid*, and the antinitrogenous substances, as starch, pectin, etc., occurring simultaneously with these acids in the various fruits. The most recent experiments instituted in Liebig's laboratory have brought to light the very surprising fact that malic acid is made to yield aldehyde by a simple process of oxidation, viz., heating with black oxide of manganese, and that citric acid will yield acetone under the same circumstances. These results confirm Liebig's theory of the constitution of tartaric acid; for the elementary constitution of malic acid is that of oxalic acid combined with aldehyde, and that of pyro-citric or

citra-conic acid, which is formed by heating citric acid, consists of the elements of oxalic acid combined with acetone.

The future investigations of these highly important discoveries promise a rich harvest for the physiological chemistry of vegetable life.—*Buchner's Repertorium.*

ELECTRICAL CONVERSION OF SUGAR INTO ALCOHOL.

At a recent meeting of the French Academy, M. Niepce St. Victor read a paper giving an account of some experiments which showed that, under certain circumstances, electricity produced the same effect on sugar as fermentation does, transforming it into alcohol. He found that by passing an electric current through very sugary white wine, the wine loses all its sugar, and becomes much more alcoholic. On the other hand, the effect of the action of light on absolute alcohol, under certain conditions, is to re-transform a portion of the alcohol back into sugar; the alcohol becoming very sugary, and having its strength reduced several degrees.

ON THE COMPOSITION OF THE ANIMAL PORTION OF OUR FOOD, AND ITS RELATIONS TO BREAD.

The general conclusions of a paper on the above subject, recently read before the Chemical Society, London, by Messrs. Lawes and Gilbert, were, that only a small proportion of the increase of a fattening animal was composed of nitrogenous matter; that from five to ten per cent only of the nitrogenous matter of the food was stored up in the body of the animal; but that the amount of fat stored up was frequently greater than the amount supplied in the food, despite the loss incurred in the maintenance of the respiratory function. Hence the comparative values of fattening foods were proportional rather to the amounts of respiratory than of assumed flesh-forming constituents. It was calculated that in those portions of the carcasses of oxen actually consumed as human food, the amount of dry fat was from two to three times as great as the amount of dry nitrogenous matter, and in the eaten portions of the carcasses of sheep and pigs more than four times as great. By substituting for the above proportions of fat their respiratory equivalents in starch, so as to allow of a comparison between meat and bread, the ratios become six or seven to one, and eleven to one, respectively. From the independent determinations of Messrs. Lawes and Gilbert, Dr. F. Watson, and Dr. Adling, it appeared that in wheat bread the ratio of starchy to nitrogenous matter was as six or seven to one, so that in bread the proportion of assumed flesh-forming constituents to respiratory constituents was greater than in the eaten portions of sheep and pigs, and quite equal to that of the eaten portions of oxen, — a conclusion altogether opposed to the prevalent notions on the subject.

A NEW ALKALOID IN COCA.

Coca is the name under which the leaves of several species of Erythroxylon are and have been known in Peru from time immemorial, and which, especially among the Indians, are used for chewing, mixed with a little unslacked lime or wood-ashes. A moderate use is said to produce such an excitement of the functions as to enable the chewer to remain some time without food,

and to bear the greatest bodily exertions; while an immoderate chewing of coca, like that of opium, frequently becomes an habitual vice, producing all the deleterious symptoms and consequences of narcotics, such as a state of half intoxication, of half drowsiness, with visionary dreams, premature decay, complete apathy, and idiocy. These peculiar symptoms rendered the presence of a narcotic principle very probable, and have induced Professor Wœhler to undertake the investigation of the substance. The examination has so far succeeded by the usual method for the separation of alkaloids, in eliminating a crystallizable base, cocaïne, crystallizing in small prisms, devoid of color or odor, slightly soluble in water, more readily in alcohol, and very easily in ether. It possesses a strongly marked alkaline reaction, and a bitter taste, and acts in so far peculiarly as it transiently benumbs or almost paralyzes the part of the tongue which it touches. It bears some resemblance to atropine in its chemical relations, and forms perfect salts with the acids.

BEET-ROOT ALCOHOL.

The following process for distilling alcohol from the sugar-beet is adopted at an establishment in Kent, England. To three-quarters of a ton of beets, which are sliced lengthwise by machinery, 300 gallons of wort prepared by maceration of beets, to start with, are poured on; a quart of sulphuric acid is added, and at the end of twenty-four hours the slices are ready for distillation. Placed in iron cylinders, divided into compartments, each compartment is drawn upon successively, so that there is a continuous flow of spirit until the end of the process. The spirit is said to resemble small-still whiskey, and under proper treatment becomes a neutral spirit, useful for many industrial purposes.

DETERMINATION OF ORGANIC MATTER IN WATER.

M. Emile Monnier presented to the Academy of Sciences of Paris an interesting note on the determination of the organic matters in the waters of the Seine. The re-agent which he employs is the permanganate of potassa. The weight of this salt decomposed being sensibly proportional to that of the organic matter, the problem is reduced to the determination of the weight of permanganate decolored by a given quantity of the water.

The test-liquor which he employs is prepared by dissolving one gramme of pure permanganate in one litre of distilled water; each cubic centimetre of this liquid contains one milligramme of the salt. To perform an analysis, proceed as follows: —

Pour into a matrass a half-litre (about a pint) of the water, and bring it to the temperature of 158° F.; add through a pipette one cubic centimetre of pure sulphuric acid; then add the test-liquor until a permanent coloration is produced; the number of cubic centimetres of this liquor added, gives at once in milligrammes the weight of the re-agent decomposed by one litre of water. At about 158° F. the decomposition of the organic matters is rapid; at common temperatures it would require more than twenty-four hours to be complete.

The sensibility of the permanganate is very great; one gramme of tannin in two cubic metres (or one part of tannin to two million parts of water), and even one part by weight of sulphuretted hydrogen in eleven million parts of water, will discolor it. — *Cosmos.*

VEGETABLE COLORING MATTER.

According to M. Filhol, there exists in nearly all flowers a substance which is scarcely colored when in solution in acid liquids, but which becomes of a beautiful yellow color when acted on by alkalies. This substance has the following properties. It is solid, and of a slightly greenish-yellow color. It is uncrystallizable, soluble in water, alcohol, and ether, and not volatile. When moistened with strong hydrochloric acid, it takes a bright yellow tint, which immediately disappears when the mixture is diluted with water, leaving an almost colorless solution, to which alkalies communicate a yellow color. The matter is found in the green parts of plants as well as the flowers, and is, no doubt, the yellow dye found in the leaves of various plants. M. Filhol adopts the name given to it by Hope, and calls it *Xanthogene*. Mosses, he says, do not contain it, or, at most, only a trace. It is also absent from some flowers, among others the *Pelargonium Zonale*, and *inquinans Papaver rheas*, Camellias and Salvias. These flowers, under the influence of alkalies, become blue or violet, without the least mixture of green. The coloring matter of these flowers is much less alterable under the influence of air and alkalies than that of most other flowers.

Chemists who have examined yellow flowers have proved that they owe their color to several immediate principles; among others, *xanthine* and *xantheine*. The author has discovered *xanthine* in fruits as well as flowers.—*Chemical News*.

ON THE POISONS FOUND IN ALCOHOLIC SPIRITS.

The following communication on the above subject, by Dr. A. A. Hayes of Boston, appears in the *Boston Medical and Surgical Journal*:—

Frequently, within the past few years, the public journals have called attention to the existence of poisonous bodies, especially strychnine, in the spirits produced from grains, and no little excitement has grown out of such announcements.

A somewhat extended series of analytical observations on these spirits, from many sources, has convinced me that no good reason for such a statement could be found, and my conclusion has been supported by the testimony of those who are opposed to the manufacture, but who frankly admit that no case has ever fallen under their notice, at the places of manufacture, which would lead to even an inference in regard to the adding of any deleterious body to the distilled spirits. The addition of non-volatile bodies to the fermented worts, if made, would not contaminate the spirits distilled from them, and it is probable that the supposition, in relation to the use of strychnine for the purpose of increasing the produce of whiskey, arose from the *ruse* of a foreman, who wished to conceal the particular characteristics of his ferments in daily use. In low places where such spirits are retailed, drugs which produce narcotic effects or temporary frenzy are doubtless resorted to in special cases, while the infusing of pepper or salt is not a very rare occurrence.

Cases of sudden poisoning by the low-priced, common spirits frequently occur, which are not necessarily referable to poisons of foreign origin. Some of the so-called *fusel-oils*, produced in the fermentation of mixed grains, either sound or after they have become injured from exposure, act as powerful poisons, and in some states of depressed action of the human

system, fatal effects would doubtless follow from the introduction of such oils into the stomach.

As a general statement, the spirits produced in this country to serve as beverages are remarkable for their purity and freedom from any substances which careful rectification can remove. When, through age and suitable exposure, the oils contained in them have passed into ethereal bodies, and thus ripened the spirits, they become equal in soundness and purity to any products imported from abroad, and far less deleterious than most of the so-called brandies of the present time.

There is, however, present in the newly distilled, and in most cases in the older spirits, a source of danger which, so far as I can learn, has been overlooked, or possibly attributed to criminal intention, which should be publicly known, and is of especial interest to the medical profession.

Newly distilled spirits, of the most common kind, often contain *salts of copper, of lead, or tin,* derived from the condensers in which the vapors are reduced to a fluid form. The quantity of copper salt contained in the bulk usually taken as a draught is sufficient to produce the minor effects of metallic poisoning; the cumulative character of these poisons may even lead to fatal consequences. With a knowledge of the fact now stated, instead of resting on a supposition of the existence of an organic poison in the spirits which have caused sickness, the physician may notice the symptoms of metallic poisoning in persons addicted to the habit of consuming newly distilled spirits, and interpose his aid in preventing the fatal termination of vicious indulgence.

Since I first demonstrated the fact of the frequent occurrence of these metallic salts in the more recently manufactured spirits, the investigation has taken a wider range, and the results have proved that as all spirits at one time were new, so with few exceptions, arising from peculiar rectifications, most spirits have been, or are, more or less contaminated by metallic compounds. Old or more matured spirits have generally lost every particle of the salts once held in solution. Changes in the organic solvent have caused the deposition of the metallic compound, accompanied by the organic matter from obvious sources, and in such spirits the metallic oxide is always found, if it has been present, in the dark-colored matter which has been deposited at the bottom of a cask at rest. This dark deposit has the appearance of, and has been mistaken for, charcoal, detached from the charred staves of the casks in which the spirits have been stored.

Of this dark deposit every sample has, on examination, afforded abundance of copper, copper and tin, or copper and lead, even when taken from the finer qualities of foreign spirits.

Observations have been made on the nature of this change from a soluble to an insoluble state. Samples of new spirits have been kept in glass vessels until the whole metallic salt has fallen in dark flocks, leaving the clear fluid free from any metallic compound and perfectly pure.

It appears, therefore, that matured spirits lose their poisonous impregnation during the time necessary to adapt them for use as beverages, and that while the clear, transparent fluid contains no metallic impregnation, a turbid though ripened spirit may prove deleterious through its *suspended* metallic compounds.

In order to avoid the poisonous effects of these salts, perfectly well-ripened and clear spirits only should be used in the preparation of medicines, and when ordered as restoratives, no new or turbid alcoholic fluids should

be allowed to enter the room of the patient or hospital. As a further elucidation of this subject, the following more strictly chemical remarks are offered.

The origin of these salts is connected with the production of acids, as well as alcohol, in fermenting vats. When the wort is subjected to heat in the still, acetic, butyric, and other acids rise with the vapor of alcohol, and pass into the condenser, now most commonly made of copper, with masses of solder containing lead. At the instant of condensation, these acids exert a power of corrosion on the metals quite unsuspected, and the salts formed dissolve in the spirit. Where condensers of pure tin are used, no copper salt is found, and a little tin salt takes its place.

With the vapor of dilute alcohol some vesicular vapor of the wort is carried forward, and the dextrine which can be found in the spirit; another portion of soluble organic matter is abstracted from the wood of the cask, and this is often tannic acid. In the subsequent chemical changes, these organic compounds unite with the salts, and fall in the form of a sub-granular, dark matter, seen in colorless spirits of all kinds. In detecting the metals held in *solution*, the extract obtained, after evaporating the spirit, must be destroyed, as usual in toxicological testing, and an acid solution of the oxide obtained; or the extract may at once be mixed with carbonate of soda, and the metal reduced by the blowpipe flame. When the deposit is the subject of trial, the metal or metals appear on fluxing with carbonate of soda, in the inner flame produced by the blowpipe, on charcoal.

ON CATALYSIS; OR, ON THE CHEMICAL AGENTS OF DISEASE IN THE LIVING BODY.

The following is an abstract of a lecture recently delivered on the above subject, by M. Claude Bernard, Professor of General Physiology of the Faculty of Sciences, Paris: —

We have hitherto maintained that idiosyncrasies ought to be referred to certain peculiar organic predispositions, which, far from introducing physiological laws of an entirely novel character into the economy, are the natural result of the properties enjoyed by the nervous system.

It is also known that animals debilitated by want of proper nourishment submit less readily to the agency of certain poisons than others in a vigorous state of health; but it has been questioned whether similar modifications are due to nervous influence, and whether the diminished activity of the absorbent powers is not sufficient to explain them. In order to settle the question at once, I injected an aqueous solution of woorara into the veins of two rabbits, one of whom had been previously fasting, while the other was duly fed; in this manner, absorption was entirely dispensed with, the poison being at once conveyed into the blood. The result was such as might have been expected. To poison the fasting animal a dose larger by one-third was required than had been found sufficient to destroy the other. It is, therefore, perfectly clear that all this class of phenomena must be entirely referred to the agency of the nervous system.

But, while the animal is in some measure preserved from the noxious influence of certain poisons through the rapidly-increasing debility of its nervous system, it becomes obnoxious to the action of morbid influences of a totally different character. It even appears to me that in our nosological

classifications this peculiar liability of the system might be turned to account as regards the etiology of disease.

To adduce a characteristic instance of this: when frogs have been kept for a long space of time in captivity their health declines, and ulcerations arise around the nose and mouth; the nervous system being in this case considerably depressed, the animal is, of course, found to resist much longer the action of strychnia and similar poisons, while parasitical affections spread with fearful rapidity. Frogs are subject to the growth of parasitical fungi, which, after a certain lapse of time, occasion the animal's death. Now, if a healthy frog is placed in a jar containing others affected with the above-mentioned disease, the new-comer sets contagion at defiance; while if another frog, affected with ulcerations in the vicinity of the natural orifices, is introduced into the jar, the parasitical vegetation covers it at once.

It has been found that similar affections always have a strong tendency to arise in animals in a low state of health. The itch, a disease which frequently prevails among horses and sheep, is scarcely ever found to attack animals in good condition; and, in man, the lower classes are known to be a prey to vermin, especially in childhood and old age; while persons who live under more favorable circumstances are scarcely ever affected with this inconvenience, except towards the latter end of long and painful diseases; for it is generally in such cases that the *morbus pedicularis* has been observed.

The decrease of nervous power equally constitutes a predisposition to putrid, contagious, and virulent affections; the fact is well known to veterinary surgeons.

It would appear, therefore, that an opposition exists between the two great classes of disease we have just examined; in proportion as the animal grows more sensible to the action of the neurosthenic poisons, the power of resisting the influence of putrid substances is increased. How is this difference to be accounted for? We shall attempt to give you a solution of the difficulty.

That the chemical composition of the blood should incessantly be modified, is one of the essential conditions of life; repairing, as it does, the daily losses of the economy, and renewing the elements of all the tissues which enter into the system, the blood may be compared to a torrent which continually pours out new substances, while other elements are flowing into it; and the stronger are the animal's vital powers, the more rapid are the successive changes of the blood; a fact principally observed in birds, which enjoy greater vital energy than any other class of animals. The uninterrupted continuation of circulation is, therefore, in such animals, of still greater importance than in others; the blood cannot stagnate without promptly acquiring septic properties. If the tributary vessels of a muscle are tied in a mammal or bird, it becomes a putrid mass within twenty-four hours; in a batrachian this change would not take place before a much longer space of time.

Now, you are aware that the nervous system presides over all the phenomena of life in which motion is concerned; as soon, therefore, as the nerves are impaired, circulation languishes, and the chemical composition of the blood becomes thereby liable to important changes. If, therefore, an animal being given, it is our purpose to preserve it from the action of woorara, or similar poisons, we must lower its forces. If, on the contrary, we intend

to preserve it from contagious diseases, we must increase them by all possible means.

But these septic bodies, or specific poisons, are almost invariably organic substances, and are produced within a living organization; here we have, no doubt, a peculiar and characteristic biological action; we need not, therefore, be surprised to see pathologists endeavoring to withdraw this class of phenomena from the domain of physiology, in order to make them the exclusive property of medicine.

We must not, however, in my opinion, give up all hope of connecting, one day, these morbid phenomena with the laws of physiology. If at present unable to do so, we shall, no doubt, succeed at some future period. Is it not, in fact, quite possible that in animals certain physiological conditions may arise which would give birth to virulent poisons? We are aware that in a perfect state of health several creatures are venomous; that is to say, they possess a peculiar virus which nature has given them for the purpose of killing their prey and defending themselves from their enemies. Here, then, we have a physiological virus; how is it produced within the system? The difficulty is quite as great as with regard to morbid poisons.

It would appear that in several cases the noxious substance prevails throughout the economy; in other cases, we only discover it in certain fluids. The virus which occasions hydrophobia belongs to the latter class; it resides exclusively in the animal's saliva. We are not yet aware whether any one of the salivary glands is its peculiar seat, or whether it is indifferently secreted by all of them. No experiments have been tried on this point; but it has been experimentally proved that the peculiar venomous principle does not exist in the blood; transfusion does not convey the disease from a mad dog to a healthy one.

It is a singular fact, and one which preëminently deserves our attention, that in so general a disease the virus, which alone is capable of transmitting the affection, should be exclusively localized within one single apparatus, without existing in the blood at large. Yet, if we reflect upon the question, we discover in the physiological state a great many similar dispositions; the principles which concur in a vast number of physiological functions,— pepsin, ptyaline, and the active principle of the pancreatic juice, are they not created by special glands? And is not the venom of serpents, which does not exist within the blood, produced by a special apparatus? Viewed in this light, a mad dog resembles a viper or a rattlesnake.

But, on the other hand, there exist several virulent diseases in which the blood really appears to contain the morbid principle. This is the case with the glanders; and it is a well-known fact that healthy animals may be infected with the blood of a diseased horse, as well as with the slimy matter that escapes from the nose and mouth.

But another particular which will, perhaps, excite your astonishment, is that the normal secretions, bile, saliva, gastric juice, and so forth, do not appear to contain the slightest vestige of this poison; while, on the other hand, the pathological fluids appear to be impregnated with it, and possess the property of transmitting the disease to sound animals,— a fact experimentally proved with regard to pus, the fluid contained in a hydrocele, and various other morbid secretions. For this reason alone are the autopsies performed on animals that die of the glanders attended with so much danger;

the virus pervades the whole system, and the slightest wound is sufficient to inoculate the complaint.

You need not, however, be astonished at this singular property; you have already witnessed the repulsion which the salivary glands evince for certain substances introduced into the blood; and why should not certain morbid principles be in this manner rejected from all the secretions in which the normal conditions remain unimpaired? The same thing appears to take place with respect to the contagious pneumonia of horned cattle. We are aware that volatile emanations transmit the morbid principle; but experiments have been tried (in Belgium) for the purpose of inoculating it directly to animals, as a preservative against the disease. Something similar to the process of inoculation in the small-pox was expected to result from this; it was then discovered that neither the animal's blood nor any of the fluids of the economy was endowed with the property of propagating the complaint. It appears to have chosen the lungs for its exclusive seat, and the liquids therein contained, pus, lymph, etc., are alone endowed with the property of transmitting the complaint. The intense local inflammation which follows the operation sufficiently testifies to the noxious properties of this virus; and when, in order not to spoil the animal's flesh, the tail is selected as the point where inoculation is to be performed, the subsequent inflammation frequently causes it to mortify.

Here, then, we have another virus which exclusively resides in the tissues of the lungs, and is not found in the blood at large; but even in the normal state a great many substances are found in various tissues, which do not exist in this fluid. Thus, muscular flesh contains a large amount of salts of potash, while scarcely any trace of them is found in the blood; in a word, the various bodies found in different parts of the economy are not invariably represented in the torrent of the circulation.

The history of specific diseases offers, therefore, nothing which cannot rationally be explained. It now remains for us to discover the physiological progress by which a virus may be originated. Nothing is easier than to produce putrid affections in sound animals. Thus, when transfusion is performed under the ordinary conditions, — when the blood is conveyed directly from one animal into the veins of another, — no accidents whatever are produced; but if the blood is allowed to remain for a short space of time in contact with the atmosphere, and if the serum is then injected into the vessels, all the symptoms of putrid resorption are observed, and the animals die after exhibiting all the characteristic symptoms of putrid infection.

The blood is, therefore, capable of acquiring toxic properties without the intervention of any foreign principle, merely through the modifications which take place in its composition when life is extinct. The same results may be attained to without even drawing blood from the veins. If the blood of a fasting animal is directly injected into the veins of a healthy one, the latter is poisoned exactly in the same manner as before; and yet the blood, in this case, has not undergone any previous decomposition.

The introduction of foreign principles, of course, acts upon the blood with still more intensity; nearly all the substances known under the name of ferments are endowed with the property of communicating a deleterious influence to this fluid. When yeast is introduced into an animal's veins, passive hemorrhage, and other adynamic symptoms, are immediately produced, and death takes place within a few days. Now, if the animal's blood is transfused into another's veins, all the phenomena previously described take place

in rapid succession, exactly as if yeast, and not blood, had been directly poured into the vessels.

It seems likely that in this case a series of decompositions take place within the blood, which give rise to other ferments. The well-known experiment related in Pringle's work on Army Diseases appears to tally with the result of our own experiments.

(In order to prove the influence of putrid emanations, even at a distance, on the chemical phenomena of life, he plunged a thread into the yolk of a rotten egg, and then suspended it in a jar containing the yolk of another egg, and under these circumstances decomposition took place with far greater rapidity than usual.)

We, therefore, perceive that all this series of phenomena hold intimate connection with that mysterious chemical process known under the name of catalysis. The theory of fermentation is at present so imperfectly known, and organic chemistry has in this respect made, as yet, so little progress, that it would hardly be fair to reproach medicine with its deficiencies on this point. There exists a whole series of diseases which evidently result from the chemical actions which take place within the body. It is, therefore, chemistry alone which, in its future progress, can teach us the physiological laws which embrace this particular branch of medicine.

CATALYSIS AND CONTACT ACTION.

It is well known that a super-saturated solution of crystallized sulphate of soda, exposed to the air, crystallizes suddenly when touched by a glass rod, but that it does not crystallize when this rod is heated to one hundred degrees Centigrade. Lœwel attributes this action to the *air* adherent to the rod; and it then becomes an interesting question, whether the air alone suffices for the production of the result, or some peculiar quality contained in the air? The latter supposition seems the most probable, since it is not caused by air which has been filtered through cotton contained in a tube, nor by air which has passed through a properly arranged series of flasks, connected by tubes of glass. Air thus agitated, or heated by friction, may be brought in contact with the super-saturated solution, under the form of a continued current, without determining the crystallization, which commences immediately in the presence of normal air. Lœwel attributes the modification produced by the air to the friction produced in his mode of experiment, and a recent experiment of his pupil Hirn proves that it is so.

The air thus rendered passive by Lœwel is called *adynamic* air. Hirn has observed that the air is rendered completely adynamic when it escapes after compression in the form of a jet from the receiver in which it was confined. After this compression it can be directed with impunity into a solution of sulphate of soda saturated by heat in a closed vessel. On the contrary, the solution solidifies instantaneously if, by the same tube, and without any derangement of the apparatus, some bubbles of ordinary air are allowed to pass into the solution. Here, then, is an action purely mechanical which replaces the action of heat, a remarkable example of the correlation of force, which raises a crowd of questions, and which leads to the inquiry, if an identical composition of the air should always have an identical action upon a living being; if air rendered adynamic by a storm is not found in different conditions, in relation to organized beings, than air long undisturbed? This brings to mind that Schrœder and Busch have shown that fermentation

is not caused by air filtered through cotton; and we now ask, if the air, rendered adynamic by the process of Hirn, will not possess still more passivity?

It is an argument more in favor of this theory, now held by the advocates of spontaneous generation, to know that it is not by germs of infusoria suspended in the air that fermentaion or putrefaction is carried on. These experiments appear to us to touch questions of the greatest importance in the sciences of observation, as well as others relating to the most interesting considerations in cosmogony. — *Silliman's Journal, November*, 1860.

ON THE ASSIMILATION OF ATMOSPHERIC NITROGEN BY PLANTS.

It is well known that a controversy has been going on for some time between MM. Boussingault and Villé, of France, respecting the assimilation of atmospheric nitrogen by plants, — the results of the experiments of the latter chemist indicating that plants *can* assimilate nitrogen, and those of the former that *no such action takes place*. At the last meeting of the American Association, Professor Pugh stated that he had, under the auspices of Mr. Lawes, the well-known English agriculturist, and at an expense of six thousand dollars, devoted three years to the investigation of this question; and the conclusion arrived at, without going into detail, was, *that no assimilation of gaseous nitrogen takes place:* a result coinciding with that arrived at by Boussingault. The experiments had been conducted with the chief cereals, wheat, barley, oats, peas, beans, buckwheat, clover, and tobacco. In regard to all but the leguminous plants, there was no doubt as to the above result. With the latter, the experiments were less decided, in consequence of their not having given results so satisfactory as in the case of the others.

ON THE EMPLOYMENT OF THE NITROGEN OF THE ATMOSPHERE FOR THE PRODUCTION OF AMMONIA, FOR FERTILIZING PURPOSES.

Since the determination of the value of ammonia, ammoniacal salts, and nitrogenous compounds generally, as fertilizers, the artificial production of ammonia has been regarded as a problem of the highest interest to agriculture. But to arrive at this result it is necessary to obtain the nitrogen elsewhere than in organic nitrogenous matters, which may, for the most part, be employed directly as manures, and of which the limited quantities and elevated price permit in any event only restricted and costly manufacture.

Atmospheric air is an inexhaustible and gratuitous source of nitrogen. However, this element presents so great an indifference in its chemical reäctions, that, notwithstanding the numerous attempts which have been made, chemists have not heretofore succeeded in combining it with hydrogen, so as to produce ammonia artificially. This result, so long desired, is reported to have been obtained during the past year by two French chemists, MM. Marguerritte and de Sourdeville, who employ as their agent in the process, the earthy base, baryta, converting it, by the aid of atmospheric nitrogen, into cyanide of barium, and producing from this last ammonia by the agency of vapor of water. The following is a brief resumé of the process employed: The baryta is prepared in the first instance by subjecting to a strong heat, in an earthen retort, a mixture of carbonate of baryta (the common ore of

baryta), coal-tar, and sawdust. Each molecule of the carbonate being thus brought in contact with the reducing agent, carbon, excellent results are obtained, the decomposition of the carbonate being easy, and the product of baryta abundant. (It was from observing the odor of ammonia, which was at times developed during their experiments upon this method of preparing baryta, that the authors were led to the discovery in question.) When the baryta thus obtained is calcined in the presence of charcoal and atmospheric air, it combines readily with carbon and the nitrogen of the air, and a formation of cyanide of barium and carbonic oxide results. This product of cyanide of barium is then received into an iron cylinder, through which a current of steam at a temperature of about five hundred and seventy-two degrees Fahrenheit is passed, and under these circumstances the cyanide of barium disengages in the form of ammonia all the nitrogen which it contains.

Trials made by the discoverers of this process, upon a tolerably large scale, are reported to have been eminently successful, leading them to hope that not only the various cyanides employed in the arts, but also ammonia and nitric acid, may thus be economically produced.

ON THE SOURCES OF NITROGEN IN PLANTS.—BY DR. CHARLES CAMERON, F. R. C.

Previous to the year 1857, our knowledge of the sources of the most important (agronomically considered) of the organic constituents of the food of plants, nitrogen, was limited to the following substances:—

Ammonia and its salts.

The nitrates of the alkalies.

The cyanides of potassium and sodium.

These substances have been proved, beyond all doubt, to be capable of furnishing nitrogen in plants; but there are other bodies whose capability of supplying this element to vegetables is still a *quæstio vexata*. These bodies are free nitrogen,—that gas which forms the most abundant constituent of the atmosphere,—and the nitrogenous organic matter termed *humus* (the altered remains of plants), a substance which is present in every fertile soil.

There are, I believe, but few vegetable physiologists who now insist that plants are capable of assimilating uncombined nitrogen; but many of the most celebrated investigators of phyto-chemistry, whilst admitting that plants derive a large proportion of their nitrogen from the ammonia of the atmosphere and the soil, maintain that the greater proportion is furnished to them by the soluble organic matter of the soil. For my own part, I have satisfied myself, by numerous carefully conducted experiments, that neither the free nitrogen of the atmosphere nor the combined nitrogen of humus can be assimilated by plants. I have further satisfied myself that the nutriment of plants can only be supplied by substances of a purely inorganic nature, under which designation I include a considerable number of substances—such as ammonia and urea—which are commonly, though I believe incorrectly, considered as pertaining to the organic kingdom. Some of the results of my researches in this domain of science have been published in various journals since 1857. These researches prove that the sources of the nitrogen of plants are not limited to the substances above enumerated; but that, in addition to these, urea and the cyanurates of potash and soda, compounds exceedingly rich in nitrogen, are capable of yielding that element to growing plants. Since the publication of these experimental results, I have

occupied myself in investigating still further the interesting subject, and I have now to announce the addition of two substances to the list of those capable of furnishing nitrogen to plants, namely, nitrate of potash and ferrocyanide of potassium. The experiments by which I succeeded in proving the availability of these bodies, as food for plants, were conducted in the following manner: —

A number of peas were selected, some of which were dried, submitted to analysis, and found to contain 4.365 per centum of nitrogen. Others were sown under the following circumstances: five earthenware vessels, respectively labelled Nos. 1, 2, 3, 4, and 5, were partly filled with brick-dust, and in each were sown eight peas. These were manured with a mixture composed of the following ingredients: The double silicate of potash and soda, chloride of sodium (common salt), carbonate of lime (chalk), hydrated sulphate of lime (gypsum), freshly precipitated phosphates of lime and magnesia, and calcined bones. In addition to this compound, which, it will be perceived, was altogether destitute of nitrogen, Nos. 1 and 2 were supplied with ferrocyanide of potassium, and Nos. 3 and 4 with nitrate of potash. Both of these substances are well known as nitrogenous compounds. No. 5 was left without any nitrogenous substance. The vessels were placed under glass shades, and supplied with sufficient light, and with air freed from the slightest trace of ammonia or of nitric acid.

The seeds were sown on the 28th of March, 1860, and, with three exceptions, germinated and developed into plants. Daily, during the growth of plants, they were supplied with carbonic acid, both in the gaseous state and dissolved in water.

On the 24th of May, the following results were observable. With one exception, the plants in Nos. 1 and 2 had attained to a fair size, and looked healthy; and, with two exceptions, the same may be said of the plants in Nos. 3 and 4; all the plants were in flower. In No. 5 the result was different; the seeds had germinated, and the plants grew favorably for a short time, but, at the period above mentioned, presented small, sickly, and decaying haulms, and no appearance of flowers.

On the 12th of July the plants to which the nitrogenous substances were supplied had perfectly matured their seeds, whilst those grown with the non-nitrogenous manures had withered away, after attaining a stunted stature, and without having made any attempt at maturation. I may here remark that the peas grown under the circumstances thus described were not what would be considered good by a market gardener, and there was but a poor return for the seed. My object, however, was not to grow a good leguminous crop, but merely to endeavor to extend our knowledge of the nature of the food of plants.

Some of the plants — straw and seed — grown in Nos. 1 and 2, were analyzed, and were found to yield an amount of nitrogen, which, compared to that contained in the original seed, was as thirty-eight to one. The nitrogen in the plants grown in Nos. 3 and 4 was found to be greater in quantity, in the proportion of thirty-four to one, than that contained in the original seed. This increase, which could only have been derived from the nitrogen in the yellow prussiate of potash and nitrate of potash, proves that these substances should be added to the list of materials capable of being used as a nitrogenous food by plants.

I intended to try some experiments this year with reference to sulphocyanide of potassium and uric acid, as sources of nitrogen for plants, but

the want of a sufficient number of large glass shades, and the peculiarly constructed vessels attached to them, which I employ in these experiments, obliged me to abandon my intention so to do for the present. Sulpho-cyanide of potassium, like the ferrocyanide of the same base, is innocuous, rich in nitrogen, and very soluble. Uric acid contains a larger proportion of nitrogen, but is very sparingly soluble. I have no doubt that both substances will be found capable of ministering to the wants of vegetable life. It is also probable that ferrocyanide of potassium is capable, like its kindred substance, the yellow prussiate, of rendering up its nitrogen on the demand of the plant. —*Chemical News*.

ON THE FORMATION OF CARBONATE OF LIME AND MAGNESIA.

Mr. T. S. Hunt, of the Canadian Geological Survey, states as the result of his recent researches, that "if we mingle in equivalent proportions the chlorides of calcium and magnesium in concentrated solution, and then, having precipitated the bases by a slight excess of carbonate of soda in the cold, expose the mixture for a few hours in a closed flask to a temperature of 200° —212° F., the pasty mass is entirely transformed into a beautiful granular powder, made up of spherical, translucent, crystalline grains, which are sparingly soluble in cold, dilute, acetic acid, and are a double carbonate of lime and magnesia. In my previous and published trials, at temperatures of 300°—400° F., the product was much less beautiful, and was mingled with carbonate of magnesia. It now remains to be seen whether the combination may not be slowly effected at a temperature much below 200° F., and experiments upon this point are in progress."

ON THE PRODUCTION OF OZONE BY MEANS OF A PLATINUM WIRE MADE INCANDESCENT BY AN ELECTRIC CURRENT.—BY M. LE ROUX.

If a platinum wire, not too large, be made incandescent by an electric current in such a manner that the ascending flow of hot air which has surrounded the wire comes in direct contact with the nostrils, an odor of ozone is perceived. The experiment may be made in the following manner: A very fine platinum wire is taken, formed in any shape, and supported in an almost horizontal position in any suitable manner. A glass funnel is placed over this, so that the air has sufficient access to the wire, on which is adjusted a glass chimney of a suitable length; the object of which is to cool the gases heated by the wire. The wire is then made incandescent by means of twelve or fifteen Bunsen's cells. The gas issuing from the chimney is found to have the odor of ozone; iodized starch-papers are altered in a few minutes when placed over the chimney. In this case, the air passing over the incandescent wire undergoes a peculiar modification by which it acquires the properties of ozone; but whether this is effected by the electricity acting as a source of heat, or by its own proper action, must be reserved for further experiments.—*Comptes Rendus*, 1860.

RESEARCHES BY M. HONZEAU ON OXYGEN IN THE NASCENT STATE.

When peroxide of barium is acted upon at ordinary temperatures by monohydrated sulphuric acid, the oxygen evolved possesses very active oxidizing

properties. A simple apparatus for the purpose consists of a tubulated flask, to the narrower neck of which is adapted a tube to convey the gas into a jar standing over water. The sulphuric acid being first poured into the flask, the peroxide of barium is added to it in small fragments, and the neck quickly closed with a cork. The disengagement of gas soon begins, and is more rapid as the acid mixture becomes more strongly heated. It is, therefore, sometimes necessary to accelerate the action by immersing the flask in a water-bath; at other times, on the contrary, to moderate it by the use of cold water.

Nascent oxygen is a colorless gas, having a powerful odor; it must be respired with caution, for if introduced into the system in large quantity it gives rise to nausea, which may be followed by vomiting. Its odor also, which at first is by no means unpleasant, becomes insupportable after smelling it frequently: its taste resembles that of the lobster.

When heated to 75° C. (168° F.), or exposed to the sun's rays, it loses all its active properties. In presence of water, and at ordinary temperatures, it oxidizes most of the metals, even silver, peroxidizes metallic protoxides, and immediately transforms arsenious into arsenic acid, etc. The alkalies (potash, soda, lime, baryta), and the stronger acids (sulphuric, phosphoric, nitric), act powerfully on it.

Ammonia in contact with nascent oxygen undergoes a true combustion, the product of which is a nitrous compound: on plunging a glass rod dipped in ammonia into a jar of the odoriferous oxygen, the vessel is immediately filled with white fumes of nitrate of ammonia.

Phosphuretted hydrogen of the non-spontaneously inflammable variety, which is not acted upon at 20° C. (58° F.) by ordinary oxygen, burns with emission of light in the odoriferous gas.

Lastly, hydrochloric acid, dissolved in water, is completely decomposed by nascent oxygen; the hydrogen is burned, and the liberated chlorine dissolves gold-leaf immersed in the modified acid.

Nascent oxygen is, therefore, a chlorinizing agent, in the same manner as chlorine is an oxidizing agent: it is, in fact, to this remarkable power of combustion in nascent oxygen that the metallic peroxides owe their faculty of eliminating chlorine under the influence of hydrochloric acid.

The odoriferous gas acts still more rapidly on iodide of potassium, liberating the iodine; it decolorizes spontaneously the tinctures of litmus, cochineal, campeachy wood, sulphate of indigo, etc., exhibiting a bleaching power equal to that of chlorine itself. Porous bodies absorb nascent oxygen, and modify it in a remarkable manner; for when the gas is slowly passed through a glass tube filled with asbestos, platinum-black, lint, carded cotton, shreds of flannel, etc., its odor and oxidizing properties are completely destroyed.

The following table gives a summary of the differences between ordinary and nascent oxygen:—

Properties of ordinary *oxygen in the free state, and at the temperature of* 15° C. (60° F.)	*Properties of* nascent *oxygen in the free state, and at the temperature of* 15° C. (60° F.)
Colorless gas, inodorous and tasteless.	Colorless gas, having a very powerful odor, and the taste of lobsters,
Has no action on blue litmus.	Rapidly decolorizes blue litmus.
Does not oxidize silver.	Oxidizes silver.

Properties of ordinary *oxygen in the free state, and at the temperature of* 15° C. (60° F.)	*Properties of* nascent *oxygen in the free state, and at the temperature of* 15° C. (60° F.)
Has no action on ammonia.	Burns ammonia spontaneously, and transforms it into nitrate.
Has no action on phosphuretted hydrogen.	Instantly burns phosphuretted hydrogen, with emission of light.
Does not decompose iodide of potassium.	Acts readily on iodide of potassium, setting the iodine free.
Has no action on hydrochloric acid.	Decomposes hydrochloric acid, setting the chlorine free.
Has a feeble oxidizing action.	Is a powerful oxidizing and chlorinizing agent.
Very stable at all temperatures.	Stable at 15° C., but destroyed towards 75°.

Peroxide of barium is not the only body which is capable of yielding active oxygen. Oxygen in the combined state possesses, indeed, the intensified power which distinguishes free oxygen in the nascent state, and which it ceases to exhibit when completely isolated, because the temperature at which it is usually evolved from its combinations is equal or superior to that at which active oxygen passes into the ordinary state.

WATER-GLASS.

The following is an abstract of a recent report of a commission appointed by the French Government to examine the several processes devised by M. Kühlmann, of Lille, for the employment of soluble alkaline silicates for hardening stone, painting, etc.

Theory of Hydraulic Cements. — The silicious solution, silicate of potash or silicate of soda, forms the basis of all the new processes. Since 1840, researches upon the origin and nature of the efflorescences upon walls have furnished Mr. Kühlmann with the opportunity of ascertaining the presence of potash and soda in most of the limestones of the various geological epochs, in larger proportion in hydraulic limestones than in fat limestones (*à chaux grasse*). What would be their influence upon the hydraulic properties of the lime? Mr. Kühlmann thought that, under the influence of potash or soda, silicious limestones might give origin, when calcined, to double compounds of lime, silica, or alumina, and an alkali analogous to those which would be obtained by the calcination of some kinds of hydrated minerals, and that these compounds, when afterwards brought into contact with water, would undergo an action analogous to that which causes the consolidation of plaster, viz., hydration, and at last perfect hardness.

The principal effect of the potash and soda would consist in transferring a certain quantity of silica to the lime, and in giving origin to silicates, which absorb water with avidity (so as to leave only that portion of water necessary to their hydrated nature), and become solidified. Numerous facts bore out this theory. Quicklime, when left in contact with a solution of silicate of potash, is immediately transformed into hydraulic lime. Quicklime and an alkaline silicate, very finely pulverized, and mixed in the proportion of eleven of silicate to one hundred of lime, likewise furnish an excellent

hydraulic lime. A mortar of fat lime repeatedly wetted with a solution of alkaline silicate is transformed into hydraulic mortar. Lastly, with the glassy silicate and lime more or less energetic hydraulic cements can be produced at will, which will be found very useful in countries where only fat limestones exist.

Silicification. — From observing the great affinity of lime for silica when set free in a nascent state from its compound with potash, Mr. Kühlmann was led to study the action of the silicates of potash and soda upon the calcareous stones,— upon chalk in particular. He observed that by placing some chalk in contact with a solution of silicate of potash in the cold, a portion of the chalk is transformed into silico-carbonate of lime, whilst a corresponding portion of potash is displaced; that the chalk hardens gradually in the air and acquires a greater hardness than that of the best hydraulic cements; if the chalk is made into a paste with the silicate, it will adhere strongly to bodies, to the surface of which it is applied. Thus a cement was discovered, capable of being employed in restoring public monuments and in the manufacture of cornice-work. Pushing his experiments further, he ascertained that chalk, when plunged into a solution of silicate of potash, was capable of absorbing a considerable quantity of silica; by exposing it alternately and repeatedly to the action of the silicious solution and to that of the air, he found that this stone acquired in time a great hardness on the surface, and that the hardening, which was at first superficial, penetrated gradually to the centre.

This silicification of the stone (this is the name given by Mr. Kühlmann to this transformation) is due to the decomposition of the silicate of potash by the carbonate of lime on the one hand, and by the carbonic acid of the air on the other. A solution of silicate of potash when left to the air gives origin, in fact, after some time, to a gelatinous and contractible deposit of silica and to a stratum of carbonate of potash. In course of time the deposit of silica acquires sufficient hardness to scratch glass. Two balls of chalk of the same diameter and of the same nature were silicified under the same conditions; the one was exposed to the free action of the air, and acquired more hardness than the second, which was kept under a bell-glass in an atmosphere deprived of carbonic acid. In silicification, therefore, as long as the stone is porous enough to continue absorbing silicate of potash, a sort of hydrated silico-carbonate of lime is formed, which hardens by gradually losing its water of hydratation, besides a contractible layer of silica which adds to the hardness of the stone. The carbonate of potash produces on the surface an almost imperceptible exudation, which diminishes gradually and at last disappears entirely, without having in the least altered the surface of the stone; by means of hydro-fluosilicic acid Mr. Kühlmann has succeeded in getting rid of the inconvenience which might result from this, and even in adding to the hardness of the stone. Calcareous stones thus prepared acquire a compact grain, and a lustrous appearance, and become capable of receiving a fine polish. The hardening is singularly assisted by heat; and calcareous porous stones, on being plunged into a high-pressure boiler containing a bath of silicate of potash, presented, as soon as they were withdrawn from this immersion, all the character of compact silicious limestones, without the least intervention of the carbonic acid of the air.

From limestones Mr. Kühlmann passed on to *porous* stones, and has succeeded in showing that the action of the carbonic acid of the air upon

silicate of potash was sufficient to effect a superficial consolidation of the stones, varying with their porosity.

Upon sulphate of lime or plaster of Paris the action of silicate of potash is essentially the same; but it is more rapid, and has the disadvantage of giving rise to the formation of sulphate of potash, which, on crystallizing, disaggregates the surfaces. Consequently, the silicious solution ought to be more diluted, so as to render the action slower; the consolidation, however, must be sufficient to avoid the effects of the crystallization of sulphate of potash.

Mode of Application. — In what way does Mr. Kühlmann apply the silicate of potash upon monuments and buildings in general? He takes silicate of potash prepared in his works, and possessing the composition of soluble glass, and dissolves it in twice its own weight of water. This solution is to be had in commerce, and marks 35° of Beaumé's areometer. All that is required is to dilute this with twice its volume of water, in order to obtain the degree of concentration most convenient for the process of hardening. In recent buildings it may be applied at once; older constructions require to be cleansed by washing with a hard brush, or by means of a solution of caustic potash, and most frequently by smart scraping. Large surfaces are sprinkled with the silicious solution by means of pumps or large syringes with divided jets. The latter have been employed in Germany since 1847. Care must be taken to collect the excess of liquid by means of gutters of glazed earthenware placed at the foot of the walls. For sculptures and certain portions of buildings, soft brushes are employed, and with great advantage, also the painting-brush. Experience has shown that three applications of silicate, on three consecutive days, suffice to harden stone. The quantity of solution which is absorbed varies with the nature of the stone and its porosity; the cost of silicate does not exceed seventy-five centimes (fifteen cents) per square mètre for the most porous stones.

Dyeing of Stones. — Mr. Kühlmann, observing that the silicification of buildings and sculptures gave rise to various colorations, which rendered, for instance, the joints more marked, was led to seek a remedy for these colorations. By means of a double silicate of manganese and potash he obtained a dark solution, which could be applied to very white limestones. By suspending some artificial sulphate of baryta in the silicious solution, he was able to introduce a little of this sulphate into the porous stone, together with the silica, in such a manner as to whiten surfaces of too dark a hue. He proved experimentally that porous limestones, when boiled in solutions of metallic sulphates (the oxides of which are insoluble in water), give rise to the fixation, to a certain depth, of these oxides in intimate combination with the sulphate of lime. With sulphate of iron he obtained a rust-color of more or less intensity; with sulphate of copper, a magnificent green tint; with sulphate of manganese, brown tints; with a mixture of sulphate of iron and sulphate of copper, a chocolate tint, etc. He observed, at the same time, that the double sulphates thus formed penetrated into the stones, and likewise increased their hardness.

Silicious Painting. — There was but one step from silicification to silicious painting. Fuchs, Professor of Mineralogy at the University of Munich, had already, in 1847, given the famous German painter, Kaulbach, all the advice necessary to enable him, by means of a sprinkling with silicate of soda, to fix the fresco-paintings which were then executed in the new museum at Berlin. Mr. Kühlmann went further, and applied the colors directly by

means of a brush. He had observed that the action exerted by carbonate of lime upon the silicates of potash and soda, viz., the displacement of silica, was likewise exerted by the carbonates of baryta, strontia, magnesia, iron, lead, etc., and even by other salts, such as chromate of lead, most of the metallic carbonates, and even the oxides of lead and oxide of zinc.

He endeavored at first to replace, in the application of mineral colors upon stone, the fixed and essential oils usually employed by solutions of silicate of potash. With white-lead, the formation of silicate of lead was too rapid to permit the application of this color by means of the painting-brush. Oxide of zinc gave satisfactory results. The artificial sulphate of baryta, which had already found employment in whitening stones of too dark a color, was again usefully employed; and, by mixing it in large proportion with the oxide of zinc, Mr. Kühlmann obtained a white color of greater brilliancy and transparency. It appeared, at first, that sulphate of baryta could not be employed by itself; but it was found that by applying it repeatedly, by means of glue or starch-paste, or by means of a mixture of starch-paste and silicious solution, it covered as well as white of lead and zinc-white in painting with size or paste colors. This observation was of the highest importance; a new white color was found which could be employed in the place of those hitherto in use.

New White Color (*Base Blanche*).—Your commission has been vividly impressed with the results already obtained by the employment of artificial sulphate of baryta in the decoration of several buildings at Lille. The brilliancy and whiteness of the finest white-lead is but dim when compared with painting in sulphate of baryta. This color possesses the advantage of remaining unaltered under the influence of emanations of sulphuretted hydrogen; it enables us to execute dim or lustrous white paintings at a saving of about two-thirds. Its use must likewise appear of immense service viewed from a sanitary point of view. It gets rid, on the one hand, of the dangers attending the manufacture and application of white-lead and oxide of zinc; on the other, of the odor of the essential oils. Mr. Kühlmann has not shrunk from establishing the manufacture of this baryta-white upon a large scale. In his works at Loos, the native sulphate of baryta or heavy spar is transformed into chloride of barium, which, when treated in its turn with sulphuric acid, at the works of St. André, is again converted into sulphate of baryta, which is thus obtained in a state of extreme division and purity.

Mr. Kühlmann, passing from whites to the various colored mineral substances, has observed that, under the influence of silicate of potash or soda, the same reactions are produced; that colors which are alterable by the alkalies cannot be employed, but that the ochres may be used, as well as blue and green ultramarine, oxide of chromium, zinc-yellow, sulphide of cadmium, red-lead, calcined lamp-black, oxide of manganese, etc.; that the colors which dry slowly may be rendered fit for painting by mixing them with colors which dry more readily, or by the addition of white colors which dry rapidly. He found, moreover, that colors which were ground with a concentrated solution of an alkaline silicate may be applied more readily upon silicified stones than upon those which have not been silicified; that in this latter case it is always useful to impregnate the surfaces, some little time before applying the colors, with a weak solution of silicate; that, in painting apartments, the ordinary process of painting in distemper will be found sufficient; and then, to fix the colors, two coats of silicate of potash

or soda, marking 6° to 10° of the areometer of Beaumé, are to be applied by means of large and soft brushes, at an interval of several hours.

Upon Wood. — Upon wood, the application of silicious painting presented some difficulties. Woods impregnated with resin do not receive the color uniformly. Wetting with the water of the solution tends to cause the wood to crack. Ash and yoke-elm, however, answer very well with a few precautions. Mr. Kühlmann has been able to submit to your commission some rather old paintings upon wood, which had resisted numerous washings, and the intense heat of a fire, close to which they were placed.

Upon Glass. — Your commission has examined with the greatest interest paintings which have been executed upon glass. Artificial sulphate of baryta, applied to glass by means of silicate of potash, imparts to it a milk-white color of great beauty; in a few days the silica is found intimately combined with it, and the color resists washing with warm water. By the action of a strong heat, this silicious varnish is transformed into a fine white enamel. Blue ultramarine, oxide of chromium, and pulverized colored enamels, may be applied. Silicious painting upon glass is destined to find advantageous employment in the construction of church windows; whilst silicious painting upon stone will serve for mural decorations.

Following the same order of ideas, Mr. Kühlmann has extended his researches to printing upon paper and upon stuffs, to the employment of silicate of soda in scene-painting and in dressing stuffs.

Upon Paper. — By grinding the finely-divided charcoal which is employed in the manufacture of Indian ink with the silicate, a writing ink is obtained, which is almost unassailable by any chemical agent.

Upon Stuffs. — In calico-printing, silicate of potash replaces albumen, which is now employed for fixing colors. The silicious solution is mixed with the colors at the moment of printing; in a few days the design acquires such a consistency that the colors resist washing and soap; provided they are not alterable by alkalies.

Printing and Dressing Stuffs. — From a series of experiments undertaken with the view of showing that in dyeing it is not correct to assume that nitrogenous substances possess a greater aptitude for receiving colors than non-nitrogenous substances, and that dyeing rests essentially upon a chemical combination with the textile material, either in the natural state or variously combined or modified, Mr. Kühlmann was induced to replace the albumen used in printing stuffs, either by a compound of gelatine and tannin, or by starch-paste fixed upon the cloth by means of lime or baryta-water, or also by the soluble silicates. In printing upon paper, he has succeeded in replacing the varnish with which it is usual to cover the colors which have been fixed by means of gelatine, by a layer of tannin, and even the gelatine itself by starch fixed by means of lime or baryta.

ON THE EXAMINATION OF CERTAIN MINERAL SUBSTANCES FOUND IN TREES.

At a recent meeting of the Boston Society of Natural History, Dr. A. A. Hayes made a report of an examination of a curious mineral substance found by Dr. C. F. Winslow in the structure of certain trees of the Sandwich Islands.

The substance occurs in the form of hollow and sometimes solid cylinders, about one fourth of an inch in diameter; small lateral holes are found opening

into and through the cylinders; the color is externally brown, and yellowish-gray when freshly fractured. The hardness is greater than calc spar or dolomite, and nearly that of fluor spar. Specific gravity, 2.414; and the general appearance that of the imitative forms of brown iron ore.

Boiling distilled water dissolves an organic salt of lime, and the solution has a strong earthy odor. Carbonate of soda solution takes up crenic and humic acids. There are no other acids or bases present. One hundred parts consist of

Organic acids and moisture,	14.46
Carbonate of lime,	72.82
Magnesia as a base,	7.32
Bi-phosphate of magnesia,	2.20
	96.80

A little silica and a mere trace of carbonate of iron were detected. The composition of this substance indicates that crenates of lime and magnesia, and some ammonia phosphate of magnesia, were absorbed from the soil, and in the subsequent decomposition the carbonate of lime formed was rendered more compact and hard by the portion of crenate which is undecomposed acting as a cement; the humus and humic acids are the usual attendants of this decomposition. The mineral substance in such cases has hitherto been found occupying the space near the concentric rings of a tree, and not the medullary canal, as in this instance.

CONSOLIDATED GUNPOWDER.

Up to the present time the received opinion among the several authorities on gunnery has been that gunpowder must be presented to the action of the firing material in a granulated condition, in order to make it explode readily. Great care has always been taken to proportion the size of the grains to the wants of each gun, it being supposed that the powder would burn more or less rapidly in accordance with the size of the grains. Captain Brown, R. A., of Woolwich, England, has, however, recently introduced with success a powder consolidated into somewhat porous cakes, but compressed into a space one-fourth less than it occupied as ordinary powder. The process by which consolidation is effected is not made public; but, as the compressed powder explodes at a slightly lower temperature than ordinary gunpowder, we conclude that some solution of an explosive compound, similar to gun-cotton, is employed. We are assured that the cylinders which have been given us for the purpose of experimenting on are composed of government powder; and undoubtedly their appearance is exactly like that which might be expected from this well-known material, supposing it to be compressed and united by some adhesive substance. They are of the Enfield bore, containing two and one half drams of powder, capable of resisting any ordinary force, and not breaking to pieces without being submitted to some strong cutting or crushing instrument. Hence they may safely be carried loosely in a cartouch box divided into compartments, and they may each readily be united to a ball by means of any gummy matter, with or without paper or a patch. We have tried these cylinders, and find them to explode just as sharply as ordinary powder, and apparently with the same power and with as little residuum. On placing them on an iron, heated over a

coke fire, side by side with ordinary rifle-powder, they explode a few seconds before the latter, showing that a lower temperature is sufficient for the purpose; but the difference is so slight as to lead to no practical result. The compressed charge is not easily affected by damp, and may be fired immediately after having been rapidly passed through water.

We are informed that the process to which the powder is submitted is very inexpensive, and, as soon as arrangements are made for its preparation and sale, it will be brought into the market at a price very little above that of ordinary gunpowder. If so, it will be a great boon to the rifleman, whether he loads his piece at the muzzle or the breech. In the former case, the solid cylinder will be rammed down entire, with very little adhesion of the grains to the sides of the barrel, and consequent injury to its explosive power. It is, however, in the breech-loader that the advantage will be chiefly felt, as, in all cases where the cartridge can be readily introduced, this compressed powder may be used without any covering whatever. Thus the skin and gossamer cartridges, as well as the paper envelops now adopted, will be entirely superseded, and miss-fires with breech-loaders will be still more rare than with the muzzle-loader. We hear that Mr. Whitworth, after a severe trial of the merits of the invention, has taken out a license to work it; and, so far as our experiments have gone, we are led to anticipate that it will be of the greatest use to his rifles, as well as to his large guns. Indeed, unless some disadvantage attends its employment which we have not discovered, we expect it will almost entirely supersede the ordinary powder. — *The Field-Sporting Journal, London.*

SUGAR A REMEDY FOR DRUNKENNESS.

Dr. Lecœur, of Caen, says that he has found in white sugar as efficacious a remedy for drunkenness as ammonia. No rationale has as yet been adduced for the action of so simple a substance as sugar, except that it serves to bring on a different fermentation than the existing one in the stomach, and to neutralize, by the formation of new compounds, the action of the liquors.

DISTRIBUTION OF IODINE.

Chatin, the well-known French chemist, insists that there is iodine in the atmosphere. He has found it in the rain-water of Florence, Pisa, and Lucca, as well as at Paris. Further, he adds that he has found it in five samples of distilled water, and three specimens of potassium from the best laboratories, and he believes that it may be found in all potassiums and most rain-waters. M. Chatin cannot succeed in isolating the iodine, but he feels none the less certain of its presence.

ON THE ATOMIC WEIGHT OF THE SIMPLE SUBSTANCES.

In a paper recently submitted to the Royal Academy of Belgium, by Professor Stass, on the atomic or molecular weight of the simple substances, a position is taken in regard to the subject greatly at variance with the views generally entertained by chemists. The author states that Berzelius, after devoting a great part of his life to endeavoring to determine chemical proportions, or equivalents, concluded from his researches that there does not exist any simple relation between the weight of the atoms of bodies, and

retained that opinion to the end of his days. In 1815, however, Dr. William Prout, in a memoir on the specific weight of gases, originated the remarkable idea that the atomic weight of bodies, well determined at that time, might be represented by multiples of the weight of hydrogen gas. This hypothesis was generally received in England, but not on the Continent, and was shown to be inexact by Turner in 1833. In 1839 and 1840, however, its correctness with respect to carbon was shown by Dumas and Stass; and also, in 1833, with respect to the elements of water, by Erdmann and Marchand; while other chemists arrived at a totally different conclusion. Since then, M. Stass has given the leisure of years to the study of this subject, undertaking his researches in full confidence in the correctness of Prout's hypothesis. Now, however, he states that he has arrived at the complete conviction that this hypothesis, and all the conclusions derived from it by Dumas and others, are contradicted by experiment, and that there does not exist any common divisor among the weights of simple bodies which unite to form definite combinations.

GEOLOGY.

THE DESERT OF SAHARA.

The following summary in respect to Sahara is translated from Karl Arenz's review of the researches of Barth, Overweg, Richardson, and Vogel:—

The Desert of Sahara has been represented as a low, flat plain, scarcely rising above the level of the ocean; a vast sea of sand, upon which, besides a few craggy lines of rock that project into it here and there, there are no other elevations but those shifting mounds and columns of sand that, like huge billows, move at the mercy of the wind; a trackless waste, where the traveller, after many days' journey, may still look in vain for a single trace either of vegetation or of animal life. Modern researches, however, do not sustain this view. On the contrary, they show beyond a doubt that the Sahara consists mostly of a series of table-lands of a greater or less elevation, jutting up occasionally into mountains, and sometimes divided from each other by valleys, or plains covered with sand, and apparently interminable. Let us take a rapid survey of the principal results bearing upon this point.

On their way from the shore of the Mediterranean to Ghat, Barth's party crossed three high and wide plateaus, parallel with the Mediterranean coast. First, came the Gharian plateau, 2000 feet high where first they ascended it, but gradually sloping as they passed on, until it terminated at the moderate height of only 500 feet. Next, the monotonous Hamadah, stretching away at a uniform height of from 1300 to 1600 feet, for 120 miles; and then, after crossing Wadys of 600 to 700 feet elevation, and miniature deserts of 1000 feet, the travellers reached the third, or the Murzuk plateau. This plateau is elevated not far from 1500 feet above the level of the ocean. Its lowest depression is 900 to 1000 feet high, while other portions attain a height of 1800 to 2200. After leaving the Murzuk plateau, the caravan, as it went toward Ghat, appears to have found a mean altitude of 1250 to 1450 feet; and so likewise for some distance to the southward of Ghat, until it came to the wild, mountainous region which lies between Ghat and Air, where it entered a Wady (Adschunscher) lying at a height of 2956 feet, and situated amid mountain peaks that were roughly estimated as about 4000 feet high. From Tin Tellust in Air, the altitude of the region was estimated at 1894 feet, nor can we suppose the southern Hamadah to lie at a much greater depression.

Though the Sahara lies at such an elvation, yet we hear of no very lofty mountains there; in Air, however, we come upon a few single peaks (the Baghtzen, Dodschen, and others), but these are only from 3000 to 5000 feet in height. Nor are there any extensive mountain chains, unless we except the line of hills between Air and Ghat, and the Uariat, which eastward of the Ghat valley stretches north and south, though even this nowhere rises to any great height. It would appear that the southern part of this quarter of the desert is even more mountainous in its character than the northern, while this in its turn, with its extensive plateaus whose scarped sides give them the appearance of gigantic blocks that have been suddenly pushed up through the ground, possesses a peculiar interest of its own. If we compare these lofty plateaus with similar elevations in Europe, we may conceive of the highest part of the Gharian as being at an equal level with the most remarkable table-lands of Europe, those of Spain and the Morea. The two other plateaus may be compared with the highest of the Swiss and South German table-lands, while the deep-lying Wady (500 feet) is about the height of the elevated plains of Bohemia.

This portion of the desert is therefore not low, but lofty; not a monotonous dead-level, but a broken highland; in short, it is a series of table-lands of different elevations. Neither is this portion of the Sahara by any means a sea of sand; in fact, only a comparatively small part of it answers to such a description. But though the Sahara, as far as our information extends, proves to be a highland, it does not follow that it is so throughout. The probabilities of the case, however, are in favor of this conclusion. The measurements of Vogel, in the year 1853, on his route from Tripoli over Sokna to Murzuk, and thence to Bilma, show that some of the eastern portion of the desert is likewise a table-land. It is true that he found the tract between the base of the Gharian and Sokna much lower than elsewhere (Boudschem is only 200 feet above the level of the ocean), but to the southward of Sokna he ascended a narrow pass of the Black Mountains to a plateau of 2000 feet in altitude, which stretched away in an unbroken surface of from 1360 to 1590 feet, as far as Murzuk, and hence it appeared probable that the Murzuk plateau at its eastern extremity merges into the Hamadah. From Aschenumma, in the neighborhood of Bilma, Vogel writes: "I have ascertained that the Great Desert is one vast plateau formation, of the general height of from 1200 to 1500 feet."

With these data before us, based as they are upon scientific research, we are prepared to give credence to the reports of the natives respecting the mountainous character of many portions of the Sahara. The whole southern region of the Tibbus Desert (Libyan) appears from such reports to be covered with high mountains and mountain ranges; in fact, near its southern border two remarkable mountain clusters have been discovered, — the Borghu and the Uadschunga, — which are so elevated that the natives dress in furs. But the loftiest mountain in the region of the Tibbus is the Tibesty, to the northeast of Bilma, which, according to our accounts, is visible at the distance of four days' journey; we know, moreover, that the Tibbus, even from the remotest parts of the country, flee for refuge from the attacks of the Tuareg to its solitary cliffs, which, with their precipitous sides, tower up from the rocky abysses at their base. These rocks are so steep that the Arabs say of them, "Your turban will fall off if you attempt to look up to their summit;" and Vogel has aptly compared them to the rock upon which the fortress of Konigstein, in Saxony, is built. In regard to the westernmost

and larger portion of the Sahara, we have similar reports from the natives of mountain chains and lofty highlands; as, for instance, of the Black Mountains, which extend from the coast far to the inland, and of a mountain chain fringed on its eastern border by several oases, that of Tuat among the rest: but especially renowned is the frowning Haghar group, with its three or four sheer, steep, and dizzy walls of rock, each wall 125 miles in length; this is said to be surrounded by an immeasurable sea of sand, and to form the stronghold of the most powerful and the most predatory of all the Tuareg tribes, that of the Haghar Tuareg, who, amid these high mountain fortresses, are compelled to go clad in woollen and furs.

And yet there remains, as well in the northern part of the Sahara as in much of its western portion, room enough for vast patches of sand or salt deserts, among which, according to the accounts of the natives, Tanezruft, lying on the route between Tuat and Timbuctoo, is the most remarkable in extent; and it may be a question whether a scientific exploration will not reveal the existence of the plateau formation at least in some portions also of this desert.

In regard to plants and animals, we find that the necessary conditions of their existence, namely, rain, is by no means so rare a phenomenon as our earlier accounts have led us to conclude. For, though Sahara may perhaps justly continue to be regarded as in the main a rainless belt, yet we find many exceptions in sudden and very copious showers, and it is altogether likely that there are many tracts, like the oasis of Air, which have their regular rainy seasons; for we find, even in the northern Hamadah, scattered thickets and a few small birds. — *Silliman's Journal.*

MEASUREMENTS OF THE ALLEGHANY SYSTEM.

It is well known to the scientific men of this country that Professor Arnold Guyot, of Princeton, New Jersey, has devoted a portion of his summer vacations for ten years past to the study of the different portions of the great Alleghany system which faces the Atlantic coast from Canada to Georgia. Several years ago he measured the highest peaks of the Adirondack, Green, and White Mountains, in the northern part of the chain, and more recently he has been at work on the southern portion of the system, which is found to possess the most elevated peaks of the whole Appalachian chain.

By a private letter from Professor Guyot, we learn that during his last summer (1860) he has devoted two full months to further measurements in the south, in company with Messrs. Sandoz and Grand Pierre. The weather has been propitious, and he has accomplished much work, having measured between one hundred and fifty and two hundred points in addition to those which were previously determined. He has extended his investigations as far as Georgia, and has seen the extremity of the Blue Ridge and the Unaka.

These measurements sufficiently indicate the grand traits of structure of that loftiest portion of the Appalachian system. It may be seen that the Roan and Grandfather mountains are the two great pillars on both sides of the Northgate to the high mountain region of North Carolina, which extend between the two chains of the Blue Ridge on the east and the Iron and Smoky and Unaka mountains on the west. That gate is almost closed by the Big Yellow mountain. The group of the Black Mountain rises nearly

isolated on one side in the interval between the two chains, touching by a corner the high Pinnacle of the Blue Ridge, and overtowering all the neighboring chains by a thousand feet. In the large and comparatively deep basin of the French Broad Valley, the Blue Ridge is considerably depressed, while the western chain preserves its increasing height. Beyond the French Broad rises the most massive cluster of highlands and of mountain chains. Here the chain of the Great Smoky mountains, which extends from the deep cut of the French Broad at Paint Rock, to that, not less remarkable, of the Little Tennessee, is the master chain of that region, and of the whole Alleghany system. Though its highest summits are a few feet below the highest peaks of the Black Mountain, it presents on that extent of sixty-five miles a continuous series of high peaks, and an average elevation not to be found in any other district, and which give to it a greater importance in the geographical structure of that vast system of mountains. The gaps or depressions never fall below five thousand feet, except towards the southwest and beyond Forney Ridge, and the number of peaks, the altitude of which exceeds six thousand feet, is indeed very large. On the opposite side, to the southeast, the Blue Ridge also rises again to a considerable height, in the stately mountains of the Great Hogback and Whiteside, which nearly reach five thousand feet, and keeps on in a series of peaks scarcely less elevated far beyond the boundary of Georgia.

Moreover, the interior, between the Smoky mountains and the Blue Ridge, is filled with chains which offer peaks higher still than the latter. The compact and intricated cluster of high mountains, which form the almost unknown wilderness covering the southern portion of Haywood and Jackson Counties, is remarkable by its massiveness and the number of lofty peaks which are crowded within a comparatively narrow space. The Cold Mountain chain, which constitutes one of its main axes, shows a long series of broad tops, nearly all of which exceed six thousand feet. Near the south end, but west of it, not far from the head-waters of the French Broad, the Pigeon, and the Tuckaseegee waters, Mount Hardy raises its dark and broad head to the height of 6133 feet. Still further northwest, the group culminates in the Richland Balsam, 6425 feet, which divides the waters of the two main branches of Pigeon River and of the Caney fork of the Tuckaseegee. Amos Plott's Balsam, in the midst of the great Balsam chain, which runs in a parallel direction between the two main chains, measures 6278 feet. Considering, therefore, these great features of physical structure, and the considerable elevation of the valleys which form the base of these high chains, we may say that this vast cluster of highlands between the French Broad and the Tuckaseegee rivers is the culminating region of the great Appalachian system.

New Map of the Alleghany System. — The measurements of Professor Guyot, just referred to, furnish important data for the correction as well as the completion of all existing maps of the regions which he has examined. These data, with the exception of those collected in the past summer, have been employed by Mr. Sandoz, a nephew of Professor Guyot, and an accomplished draftsman, in the construction of a new map of the entire Alleghany chain, which has been published in the July number of Petermann's *Mittheilungen.* Mr. Sandoz has accompanied Mr. Guyot on many of his mountain expeditions, and took the results with him to Gotha, where the chart was drawn and engraved under the direction of Dr. Petermann.

The scale of the map is 1 : 6,000,000. Two detailed subordinate maps are

printed on the same sheet with it, having a scale of 1 : 600,000, one of which gives the White Mountains of New Hampshire, the other the Black Mountains of North Carolina, both according to Mr. Guyot's measurements. — *Silliman's Journal, Nov.* 1860.

ON THE GEOLOGY OF THE WHITE MOUNTAINS.

At a recent meeting of the Philadelphia Academy, Mr. J. P. Lesley communicated the result of some recent observations on the Geology of the White Mountains of New England. His examinations of these mountains had led to the conviction that the range would prove to be *synclinal* instead of *anticlinal*, and therefore probably of Devonian age. A section which he made in 1857 along the Grand Trunk Railroad showed him the synclinal structure, with comparatively few dips, and at least two main anticlinal divisions. The profile in the Franconia notch is evidently a cliff outcrop of a horizontal plate. The newly opened Greely Mountain House in Waterville, in a cul-de-sac valley at the head of Mad River, and six or eight miles in an east line through the woods from the Flume House, is surrounded by bold outcrops of nearly horizontal massive plates of granite. Ascending Mad River from Campton, the traveller has the White-face range on his right, with apparent gentle dips to the northwest. But on his left he has the Welsh mountain range and Mount Osceola, with an unmistakable and universal dip, never over fifteen degrees, and much of it under ten degrees, to the southeast, which can be studied for at least seven miles, northeast and southeast. Turning to the left and ascending Mount Osceola (which Mr. Lesley found by barometer to be over 2600 above the Greely House, and therefore not much lower than Mount Lafayette), the bridle path mounts over successive outcrop edges of perfectly horizontal plates of granite, as evidently and regularly bedded as any of the sandstone masses of the Alleghanies, the bed planes not being at all disguised by the cleavage planes. Between these plates of granite lie plates of unchanged dark blue sandstone, — a rock which at the cascades (two miles from the house in another direction) has been mistaken for greenstone trap. The successive terraces and cliffs of the mountain are evidently the consequences of this horizontal and alternate structure. As in other horizontal mountain plateaus, the terraces here are projected between the ravines in the form of noses, with straight crests, and terraced or stepped at their ends. In fact, to a practised topographical eye, the aspect of the whole White Mountain range is that of synclinal erosion.

Other considerations reinforce this opinion. The continuation and broadening of the range northeastward through Maine and Lower Canada, where super-silurian rocks abound, — the termination of the range southeastward before reaching Massachusetts and Vermont, as the Alleghany synclinal stops at Catskill before crossing the Hudson, — the presence of horizontal rocks at Worcester, and, more generally than would be supposed, through middle New England, — the fact that the Connecticut valley runs everywhere under the western escarpment of the White Mountains, separating it from the silurian range of the Green Mountains, and the presence of Potsdam and other low formations in eastern Massachusetts, — all these facts would find their explanation in a synclinal terminal eroded structure of the White Mountain mass.

The granite of Mount Osceola and the surrounding heights consists of

large crystals of feldspar, smaller crystals of quartz, and smaller flakes of mica. Here and there hornblende appears. The rock bears no resemblance to the sub-silurian Highland and Blue Ridge range and Adirondacks. It is friable under the weather, shedding its crystals upon the ground under every overhanging ledge. The boulders are rounded by the weather action apparently more than by movement; for they have only travelled down the slopes beneath the cliffs from which they have fallen, and where those that remain are sharp-angled. The peculiar gravel and sand of the Mad River valley is a local drift of similar origin. The metamorphism of these granites is considered by Logan, Hunt, and others, as no longer disputable. They could easily originate in the clayey sandstones of Formations VIII., IX. and X., of the Appalachians.

Considering the whole White Mountain mass a synclinal plateau, then the summit of Mount Washington, which is such an acknowledged anomaly, becomes regularly the single residual fragment of the highest formation which escaped erosion. Its rock is so different in texture and structure from the rest of the mountains that no other explanation seems possible; and if this hypothesis be adopted, there is no longer any need of that which supposes the submergence of New England *up to the base* of the head of Mount Washington *and no higher*, leaving the head in the air to escape the general rounding and polishing action. It becomes easy to consider the external difference due rather to the difference of the rock formations above and below that horizon.

THE HIMALAYA MOUNTAINS.

The brothers Schlagintweit, who have recently returned to Europe from an exploration of Thibet and Napaul, Asia, state that they succeeded in reaching the summit of Ibiganuri, one of the Himalaya Mountains, 22,260 feet high, which is the greatest height ever attained on any mountain. The peak lately called Mt. Everest, of the Himalaya chain, is the highest mountain in the world at present known, being considerably over 29,000 feet above the level of the sea. The natives have two names for it—one of them, Gorishanta, which is mythological, is to be found only in the Nepaulese, and the second name, Chingofanmara, is that by which it is known among the people of Thibet.

ON THE CONDITIONS OF SILICA AND THE FORMATION OF GRANITE.

The following is an abstract of an important essay recently published in *Poggendorff's Annalen*, which has excited no little attention among European scientists, as it tends to the denial of the prevailing theory of the igneous origin of granite. According to M. Rose's observations, there are two different states or conditions of silica, one having a specific gravity of 2.6, and the other varying from 2.2 to 2.3. The silica or silicic acid, with the density of 2.6, is only found in the crystalline form, or in a compact form more or less crystallized, while that with the lower specific gravity is always amorphous. The properties of the regularly crystallized and the compact crystalline forms are similar, and differ from those of the amorphous varieties. M. Rose observes, that no one can doubt that compact crystallized silica, such as is found in fire-stone, for example, has been formed in a moist way. In petrified wood we often find the vegetable structure accu-

rately preserved, and Ehrenberg has detected infusoria in fire-stone with their forms uninjured. Powdered quartz, or fire-stone, resists the action of boiling hydrate of potash, or, after prolonged exposure, is only slightly dissolved, while amorphous silica is dissolved in considerable quantity. Experiments to produce crystallized silica have only succeeded when the humid method has been tried: among others, Daubrée produced well-formed crystals of quartz by decomposing glass by the action of water at a high temperature and under pressure. But no one has obtained crystallized silica by the method of fusion, and quartz which has been melted has a specific gravity of 2.2. Davy, Clarke, Stromeyer, Marcet, and others fused quartz into a clear globule; and more recently, Gaudin and St. Claire Deville have melted considerable quantities of quartz, which they formed into buttons and drew out in threads; but although the quartz had a specific gravity of 2.6 before fusion, after it, its density was reduced to 2.2. M. Rose observes, that it is not likely that the quartz of the granite crystallized during a slower cooling, or by the prolonged action of an elevated temperature, because, if such an action had taken place, it would have been irregular in its operation, and where the cooling was accelerated we should expect to find silica with a density of 2.2, which, however, never occurs in any sort of granite.

Different modifications of silica were exposed to an elevated temperature in a porcelain furnace at Berlin (estimated at two thousand Centigrade degrees) for eighteen hours, and then cooled very slowly. The specimens of silica were placed in platina crucibles, which were in turn placed in larger crucibles of the same metal, contact being prevented by the interposition of magnesia. A rock crystal thus treated was unchanged, except that some small fissures occurred in the side nearest the platina, and which was consequently cooled quickest. By exposing a second time some quartz crystals to the action of the furnace, the lower portions of which exhibited a few cracks, the latter were after exposure reducible to a granular state by the action of the fingers. The grains thus obtained were for the most part transparent and crystalline, but some of them were opalized and easily reducible to powder. The coarse powder had a specific gravity of 2.613, thus showing that some weight had been lost. The second portion of these crystals remained uninjured. Rock crystal, reduced to as fine a powder as possible, was then placed in a furnace, and its density was found to be 2.394. By a second exposure it was reduced to 2.329. Black fire-stone, with a density of 2.591, preserved its form after the action of the furnace, but those portions in contact with the platina were cracked, and the mass was rendered completely white and easily reducible to powder in a mortar. The specific gravity of the whole was 2.218, and of the powder 2.237. By these experiments it was shown that the prolonged action of a high temperature produced different results, according to the mechanical condition of the crystalline silica, and that a temperature insufficient for fusion enabled the crystalline silica to pass into the amorphous state.

The modification of silica which has a density of 2.2 is obtained not only by fusion or heating the crystalline form, but when it is melted with alkalies and precipitated in a gelatinous form. When the gelatinous silica is thoroughly dried, it becomes pulverulent with a density of 2.2 to 2.3. No rigorous line of demarcation can be drawn between the silicates which we see in nature, and which resist the action of acids, and those which are decomposed by them. In fact, many of those which have been ranged

among the nondecomposed forms are, more or less, acted upon when they are reduced to a fine powder and exposed to a long digestion with concentrated acids. But in the decomposition of silicates which acids attack with difficulty, silica is always precipitated in a pulverulent and not in a gelatinous form. From the different states in which silica is separated by the action of acids, Bischoff considered that it exists in two isomeric conditions. To test this theory, M. Rose prepared pulverulent silica from stilbite, with the aid of concentrated hydrochloric acid, and found its density when dry at 150° was 2.145; after a little water left at this temperature was expelled by slight calcination, the density was 2.1897, and after half an hour's exposure to a red heat, it was 2.206. Gelatinous silica was then obtained with hydrochloric acid from apophyllite, and possessed a specific gravity of 2.218, and, after calcination for half an hour near a reddish white heat, of 2.22. It therefore appears that silica possesses the same density and the same properties in whichever condition it is separated from its combinations by acids. The envelops of infusoria are formed of amorphous silica, do not polarize light, and have, according to Schaffgotsch, a specific gravity of 2.2. Thus, while the silica resulting from inorganic changes effected in nature by the humid way is of a specific gravity of 2.6, the phenomena of organic life transform this into silica with a density of 2.2.

The original paper further presents a mass of valuable detail which cannot here be reproduced, after which the writer applies his researches to the theory of the production of granite, and lays stress upon observations tending to show that the quartz was crystallized after the felspar and mica, whereas it would have been the first to crystallize if all had been fused together, because it is the least fusible, and would solidify soonest. By melting granite, M. Rose obtained a black glass mingled with portions of silica. Various other reasons are given for reviving the Neptunian theory; and the writer concludes that it is possible that the constituent elements of granite may have been formed by the action of water on a mass originally in fusion, and considers that the high temperature and circumstances under which the action took place would account for the absence of organic remains. It is obvious that this theory affects not only granite, but porphyries and other supposed igneous rocks. M. Rose, however, admits that if any one should succeed in forming crystalline silica by fusion which should possess a density of 2.6, the principal objections against the igneous origin of granite would disappear.

ON THE FORMATION OF MINERALS IN THE HUMID WAY.

In a communication on the above subject recently made to the Boston Society of Natural History by Dr. C. T. Jackson, he remarked of chemical springs, that they are generally found along the line of disruption of strata of rocks, and near the junction of eruptive rocks with those of aqueous deposition. In the Vosges, it is at the line of contact of granite and the new red sandstone that the hot springs of Plombiéres are found. The waters of these springs have a temperature of seventy-three degrees Centigrade, or one hundred and sixty-three degrees Fahrenheit. These waters contain 0.03 grammes of silicate of potash per litre. Ancient Roman baths were found at these springs, and the river had been turned out of its natural channel into an artificial one, in order to accommodate the construction of the baths. In these ancient works were found bronze stopcocks, in which

the bronze was changed into gray sulphuret of copper. In the bricks of the Roman works, numerous crystals of zeolite minerals were found, which had been formed in the cavities by the action of the mineral-waters; also small crystals of fluor spar. Among the minerals thus formed are Apophyllite, Chabasie, Chalcedony, Malachite, Haematite, Opal, Hyalite, Arragonite, Calcareous Spar, and a variety of other minerals. The alkaline mineral-waters acting on the components of the bricks and cement formed double silicates most readily. The Apophyllite was found in the cement, and not in the bricks, while Chabasie was found in the bricks.

The conditions required for the formation of zeolite minerals are fulfilled most perfectly when trap rocks are thrown in a molten state into beds of new red sandstone strata. The humid sandstones and slates of that series are in the very condition required for the chemical combinations to take place, under the heat of the trap rocks and the influence of heated saline waters. Trap breccia is a mixture of scoriaceous trap rock and sandstone. Amygdaloid is the scoria produced by the interfusion of trap rocks and sandstone. Now, in Nova Scotia, all along the shores of the Bay of Fundy, we find in the utmost profusion the Zeolites, Quartz and Amethyst geodes, Apophyllite, Stilbite, Mesotype, Analcime, Agates, etc., in the Amygdaloid, but not in the compact trap rocks. So on the south shore of Lake Superior, where the trap rocks have been erupted through and between the strata of new red sandstone, we find the Amygdaloid at the point of contact of the trap and the sandstone, and the Amygdaloid is filled with an abundance of Zeolite minerals, Agates, Chalcedony, etc., while the compact trap rocks are not charged with these minerals. Dr. Jackson therefore inferred that these minerals were produced in the Amygdaloid by agencies such as are cited by M. Daubrée.

Sea-water undoubtedly played a conspicuous part in effecting changes in the composition of rocks, and in the formation of minerals contained in the metamorphosed rocks; and it is probable, in accordance with the views of Forchammer, Mitscherlich, Marignac, Sénarmont, Favre, and Hunt, that the magnesia of the Dolomites came from the decomposition of the chloride of magnesium of sea-water, and that gypsum was also produced by the reaction of the sulphate of soda on carbonate of lime. Forchammer found that when sea-water was heated with bicarbonate of lime magnesia was precipitated, and the proportion augments at higher temperatures under pressure. He found also that gypsum was decomposed in fourteen days when in contact with carbonate of magnesia, and sulphate of magnesia and carbonate of lime resulted. Marignac found at two hundred degrees Centigrade that chloride of magnesium and carbonate of lime, reacted on each other, and that double carbonate of magnesia resulted. Sénarmont made a similar experiment. Favre estimates that an ocean pressure of from five hundred to six hundred feet is adequate to effect these changes when the water is heated.

ON THE ORIGIN OF CERTAIN ELONGATED, FLATTENED, AND CURVED QUARTZ PEBBLES FROM THE CONGLOMERATE OF VERMONT.

At a meeting of the Boston Society of Natural History, October, 1860, Professor Edward Hitchcock, of Amherst, made a communication on the conglomerate of Vermont, which contains elongated, flattened, and curved

pebbles of quartzose nature, and sometimes of pure hyaline quartz. His observations had been made at Newport, R. I., where these distorted pebbles were first noticed, and at Wallingford and Plymouth, Vt., in the Green Mountains. He exhibited diagrams, showing the size, shape, and relation of these pebbles to the conglomerate enclosing them, and the gradual passage of the rounded and water-worn masses into the folia of the schists. At Newport the greatest elongation is in the direction of the strike, but in Vermont in the direction of the dip; in Plymouth he had found the pebbles of one surface continuous with the schistose laminæ of another. In some localities this quartzose conglomerate is intimately associated with gneiss, and seemingly a variety of it; he had no direct proof of this, but believed that there is a continuous series of changes from these quartzose elongated pebbles, through the talcose and micaceous schists, to the gneiss, that are all varieties of the same rock. The gneiss of the Green Mountains has these conglomerates and schists on the east and west sides, the former being the uppermost. He expressed an opinion that these pebbles have been bent since their deposition, and while they were in a plastic state; they are not only elongated, but indented and curved around each other in some localities; the simple curvature of the strata might explain the elongation in the line of strike, but not the other phenomena presented. Some of these pebbles in Vermont are pure quartz. To explain this he invoked the aid of chemistry, and the well-known action of hot water containing alkalies in solution in softening and decomposing silicates, extracting some ingredients and combining others, the form of the rock remaining unchanged.

Dr. Jackson thought that the smoothness and absence of indentation in these pebbles showed that no change had taken place in the forms since their deposition; they are perfectly polished, as in the stones rolled upon our shingle beaches by the powerful action of the surf. This constant grinding and rolling up and down by the force of the waves would produce various cylindrical forms, and even the crooked and distorted ones exhibited on the diagrams of Mr. Hitchcock; and similar shapes can be seen any day upon the present beaches. Beside, quartz pebbles could hardly have been softened by heat, and, if they were, would have taken different forms from these. The magnetic iron he considered the result of a metalliferous emanation, rising in vapor, as in almost every volcanic eruption, and requiring less than a red-heat. They were parallel to each other and to the line of the strata, because they were thus formed originally. In presence of sea-water, a moderate heat would be sufficient to cause the pebbles to be united by a cement of Wollastonite or silicate of lime. He was averse to any theory of their explanation which requires softening after their deposition.

At a subsequent meeting of the Society, Professor Rogers, after referring to the character of the conglomerate as presented at Newport, R. I., called attention to the steep and alternating dips of the beds of conglomerate in question, and also to the general parallelism of the flat sides of the pebbles to the planes of deposition, as well as the prevailing uniformity of the direction of their longer axes. He urged that such an arrangement of the pebbles corresponds precisely with the effects of wave and current action on water-worn and partially water-borne fragments during their accumulation. The large proportion of pebbles of elongated shape met with in these peculiar beds, was, he considered, the natural consequence of the mode of disintegration of the original metamorphic rocks from which the

pebbles were derived. Such rocks, in virtue of sharply-intersecting joints and cleavage planes, are prone in many localities to break up in long, irregular, somewhat rhombic figures, which, by the wearing action of streams and tides, are easily converted into oblong pebbles, like those of the Newport conglomerate. Examples of this mode of disintegration are common in the more altered belts of the Appalachian region, especially among the siliceous and argillaceous slates along its southeastern border, and may be seen at various points among the similar altered rocks of New England.

To the hypothesis of Prof. Hitchcock, that these elongated pebbles owe their peculiar shape and position to the action of powerful pressure upon the strata while the pebbles were in a soft condition, from intense heat or other causes, Prof. Rogers urged the following objections:

1st. The effect of pressure upon a plastic solid, as shown by Tyndall and Sorby, is in all cases to develop more or less distinct cleavage planes throughout the mass; these planes being uniformly at right angles to the direction of the pressing force. Such an action applied on a large scale to the strata of conglomerate must, therefore, have had the effect not only of flattening the plastic pebbles in a uniform direction, but of developing a cleavage or lamination in them all, parallel to their flat sections as they lie in the mass. But this is so far from being the fact, that we find the cleavage planes of different pebbles running in wholly different directions, sometimes across, sometimes parallel, and sometimes oblique, to the general bedding, just as might be expected from the preservation of the original cleavage-structure of the rock from which they were derived.

2d. Such a moulding of the pebbles by pressure would either enormously distort or entirely obliterate any fossil forms or impressions which may have existed upon or within the pebbles at the time of their deposit. But an inspection of the Lingulæ from the Taunton River conglomerate, and of a similar fossil found subsequently by Mr. Easton in the conglomerate of Newport, shows that no such violence could possibly have operated on the mass.

3d. While in the localities referred to the *majority* of the pebbles have the oblong shape and parallel arrangement above described, there are many scattered through the mass which are either round or have their longer dimensions more or less transverse, or even perpendicular, to the general direction. As these could not have escaped the enormous, all-pervading softening action and pressure which the hypothesis assumes, their presence in these discordant conditions seems of itself a sufficient refutation of the theory.

In regard to the curved form and close adaptation observed in some of the pebbles, Prof. Rogers thought that accidental peculiarities of shape in the original fragment, and the effects of attrition and the close packing of the accumulated deposit, furnished an adequate explanation both of the bent form sometimes met with, and the accurate fitting of the contiguous pebble to its concave surface.

As an example of the formation of flattened pebbles by the action of the shore waves, Prof. Rogers referred to paving stones of slaty trap, recently imported from Newfoundland, which are remarkable for their very uniform circular outline, their smooth, slightly convex faces, and a thickness rarely exceeding one-third of their breadth. If we suppose a great mass of these as they lie piled along the shore, with their broad sides

horizontal, to be hereafter cemented together as a stratum of conglomerate rock, would not the argument founded on their shape and position be even stronger than in the case of the Newport conglomerate? Yet nothing is more certain than that they owe their shape and arrangement to the peculiar movement and attrition to which they have been subjected by the action of the waves.

Thus, as regards the Newport rocks, and most other conglomerates which had fallen under his notice, Prof. Rogers saw no difficulty in referring the form and arrangement of the pebbles to the familiar agencies above indicated. He did not, however, doubt that, in some highly metamorphic districts, conglomerate rocks were to be found which had sustained great internal changes through the effects of heat, chemical action, and violent pressure. Such he has long thought must have been the conditions in some parts of the Blue Ridge and South Mountain chain in the Middle States, and such, perhaps, were the influences which operated on the gneissoid conglomerates of the Green Mountains, to which Prof. Hitchcock has referred in his communication to the Society.

ON THE FORMATION OF TRAP DIKES.

At the meeting of the American Association, 1860, Mr. J. D. Whitney read a paper, prepared by himself and Col. Foster, on the origin and stratigraphical relations of the trappean rocks of Lake Superior. It was a minute description and discussion of the traps found in the Lake Superior region, especially about the copper mines at Keweenaw Point, and presented as many objections as possible to the theory, now pressed with much vigor, that trap is not of igneous origin.

Prof. Agassiz quite concurred with the authors of the paper, that an examination of the shores of Lake Superior fully established the igneous origin of trap. The evidence of the heated mass upon the sandstone below was as plain as that of a hot poker upon wood. He thought that if the advocates of the aqueous origin of the trap would examine some of these places, they would be convinced that they were wrong.

Prof. Wm. B. Rogers coincided in maintaining the igneous origin of trap, and adduced some instances supporting that theory.

Prof. Agassiz said that he had observed the influence of the rocks upon the dikes, as well as the influence of the dikes upon the rocks. There was a very good instance of this at Nahant, where the influence of the rock in producing a slow cooling of the hornblende was seen in the very large crystals there found.

ON THE TEMPERATURE OF THE EARTH AT GREAT DEPTHS.

At a recent meeting of the Boston Society of Natural History, Prof. W. B. Rogers remarked, that in reference to the increase of temperature at great depths, as a means of determining the thickness of the solid crust or shell of the globe, much uncertainty must attend such calculations until all the necessary data have been ascertained. It is not merely requisite to know the law according to which the temperature augments as we descend, and the *ordinary* melting point of the different rocky materials forming the crust, but we must ascertain how and in what degree the melting point in

each case is influenced by the pressure to which the heated mass is subjected.

According to the experiments of Bunsen, Hopkins, and others, spermaceti, wax, and paraffine, when heated under powerful pressure, require a higher temperature for their liquefaction than is sufficient to melt them under ordinary circumstances, where the pressing force is only that of a single atmosphere. If, with Hopkins, we assume that the melting point of rocks is in like manner raised by the pressure under which they are placed beneath the surface, we must agree with him in the conclusion that the materials of the earth's crust may retain their solid condition to a much greater depth than has been usually supposed.

We have, however, no warrant for assuming that all, or even the great mass of rocky materials, obey the same law in regard to their liquefaction as wax and the other similar substances above named. It should be remembered that these latter belong to the class of substances which contract as they pass from the liquid to the solid form, while there is another class, typified by ice, in which the act of congelation is accompanied by more or less expansion. Now it has been proved experimentally by Thompson, that pressure, instead of raising, actually lowers the melting point of ice; and there is reason for regarding it as a general law, that all those bodies which expand in becoming solid are similarly affected by pressure, while the other bodies which, like wax, contract in congealing, have their melting point raised under the same circumstances.

As yet we are too little acquainted with the habitudes of the various rocks in these respects to decide as to the extent to which the one or other of these opposite agencies of pressure upon the melting point may operate in the interior of the globe, or to form any valid conclusion as to their aggregate effect upon the computed thickness of the crust.

THE COSO MINING REGION OF CALIFORNIA.

A correspondent of the *Alta California*—Mr. Farley—thus describes the geological features of a new mining region in the southeastern part of California, known as the "Coso Mining Region." Its area is about eighty miles square. It has for natural boundaries the Sierra Nevada on the west, the lofty peaks of Owens' Mountains on the north, and an extensive dry lagoon on the east: —

Nature seems to have withheld from the Coso mining district all save mineral wealth that can render a country attractive to man. It is treeless, and, with the exception of boiling springs, waterless, and it is in rare instances that even a limited tract of land can be found susceptible of cultivation. Birds are scarcely ever seen, and only deer are found in remote places, where scanty signs of vegetation exhibit themselves. Roaming over the country are a few scattered Indians (the Coso tribe), who, like those of Washoe, live on herbs, roots, and worms. They run swiftly away upon seeing the whites. They build huts of cane, and huddle together in the cañons, where they pass a wretched, lazy existence.

About twenty miles to the southward of Silver Mountain, the party visited an active volcano, at some elevation above the surrounding country, and which threw out hot mud and steam. A curious feature about this was, that, at distances of three feet apart, there were holes, each of which vomited forth different colored mud,—some scarlet, others a bright yellow, and

others as blue as indigo. This spurted out in thick, gluey consistency, ran slowly down the sides like lava, and cooled to a substance hard as rock. Not far from this mud volcano they visited an opening which emitted the most unbearable heat, as from an oven, and here the Indians had been accustomed to bring rabbits, lizards, and other game to be cooked, — nature furnishing the fuel and fire gratis.

In another direction, they discovered a tremendous boiling spring, forty feet long by about twenty-five wide. This appeared to be of immense depth, and was heated to the boiling point, presenting, in fact, an enormous caldron of boiling water, bubbling and steaming exactly as a pot would do over a hot fire. The water, when cooled, had an intolerable taste of alum. The hissing and roaring of this boiler could be heard at a great distance. It is described as shaking the ground, and emitting a loud subterranean rumbling. All the country around for twenty miles seems to have been burnt up with a fierce heat. The ground is hot for a mile around the volcano, and the peaks of the hills are all heated.

Mr. Farley had a narrow escape near one of the hot mud lakes. Not being aware of the treacherous nature of the ground, he turned his horse towards a green-looking place, where there appeared to be something like feed. He had advanced but a few yards when the crust upon which the horse trod began to break through, while the ground began to bend in and tremble, as in a morass or quaking bog. His horse reared, and when the rider attempted to turn him, he broke through, his feet entering into a hot substance below, which stripped the hair and skin off the hind legs of the animal in a moment. It was with the utmost difficulty he was spurred to more solid ground, and the mud which was taken up was found to be too hot to hold in the hand for an instant. The country seems to be in a state of subterranean combustion. Where the hills have been broken down, or, in other words, where land slides have occurred, the precipices are white as drifted snow, as though immense lime-kilns had caved in.

ON THE CHANGE OF CLIMATE IN DIFFERENT PARTS OF THE EARTH.

The following is a resumé of a series of letters recently communicated to the London *Athenæum*, by Sir Henry James, Director-in-chief of the Ordnance Survey of Great Britain, which, from novelty of the views expressed, and the high scientific position of the author, have attracted no little interest, and called forth considerable discussion: —

No fact has been more clearly established by geological evidence than that in former periods of the earth's history there have been great and extraordinary changes in the climates of its different regions. The fossil faunas and floras of the Arctic regions prove incontestably that in that portion of the earth the climate must at different periods have passed through every variety, from the tropical to the arctic; in this our own country we have the same conclusive evidences of similar changes; and evidence can be produced from every part of the earth, all proving the same great fact, that there has been everywhere a great change of climate.

Various speculations have been advanced by geologists to account for so remarkable a fact, and attempts have been made to prove that in the subsidence of continents and the raising up of the bottoms of seas, and other great changes with which we are familiar, there might have formerly existed

such a distribution of the land and water as would account for the observed phenomena. Others again have supposed a higher temperature in all parts of the earth, derived from the central heat of the globe, and everywhere producing contemporaneous similar faunas and floras.

Without here entering upon the discussion of these views, I believe there are few geologists or naturalists who accept these explanations of the causes of the changes in climate as in any degree satisfactory. I have constantly had this problem before me, deeming it to be one of the very highest interest in physical geology, and have long since arrived at the conclusion that there was no possible explanation of the phenomena without the supposition of a constant change in the position of the axis of the earth's rotation; and I think there are other great facts in physical geology which cannot be explained under any other supposition.

The question we have to consider is, whether there may not have been, during those vast periods of the earth's history which geology unfolds to us, some causes in operation which may have produced the supposed changes in the position of the poles of the earth; and it appears to me that if we take for our guide the investigations of Newton upon the effects which a redundancy of matter on any point of the earth's surface must necessarily produce, they will lead us to the conclusion that there must formerly have been changes in the position of the poles, with the consequent changes of climate on every part of the earth.

I assume, as an admitted fact, that the mass of the earth was at first a fluid mass, and that it is at present a fluid mass with a hardened crust, and that the present oblate form of the earth is due to its rotation on its axis; and that if we suppose any cause which would tend to produce a change in the position of the poles, the mass of the earth was at all times, and is still, free to assume the new form which its revolution on a new axis would tend to produce, but with certain changes in the hardened crust, to which I will not further allude than to say I refer to what is called "slaty cleavage," which, passing through vast masses of rocks, which are spread over large areas, has split up the rocks into laminæ as fine almost as the imaginary fluxional increments of the mathematician, and also to the vast number of "faults" by which the rocks forming the crust of the earth are broken up, and to the undulations of the strata in nearly parallel folds over large areas. Every geometrician must see that this is precisely such a result as might be expected under the supposition of a change in the position of the poles, with a corresponding change in the form of the earth. To take a simple illustration: if we hold a thick book between the hands, and imagine the surface formed by the edges of the leaves to represent the surface of a homogeneous mass of rock, such as that out of which slates are formed, and we then depress one side of the book so as to make the surface slightly inclined to its original position, it will be seen that an almost infinitesimally small sliding movement is given to each leaf, and that this represents what must take place under the hypothesis in a homogeneous rock, and produce the "slaty cleavage." If, again, we place a number of books side by side on the ground, and then push them on one side, it will be observed that each book will slide, to a certain extent, over the one beneath it, and that this dislocation will represent the "faults" which occur through any compound series of strata, such as the coal-measures, and it will be observed that the displacement is down the inclined plane, as is always observed in the "faults." The strata in each case are supposed to have been originally horizontal.

In the 66th Proposition of the 1st Section of the *Principia*, Theorem 26, Corollary 22, Newton says: "But let there be added anywhere between the pole and the equator a heap of new matter, like a mountain, and this by its perpetual endeavor to recede from the centre of its motion will disturb the motion of the globe, and cause its poles to wander about its superficies, describing circles about themselves and their opposite points."—*Motte's Translation*, 1729.

We have no evidence that within the historic period there has been an elevation of any mountain mass of such a magnitude as could produce an appreciable change in the position of the poles or the equator, and no records of astronomical observations could, therefore, show any such changes as have been adverted to. But we have undoubted evidence that in the former periods of the earth's history great mountain regions, such as the Andes, the Himalayas, and the Rocky Mountains, have been thrown up in well-defined successive geological epochs; and knowing how vastly greater these mountain masses must originally have been, from the great degradation to which in the lapse of ages they have been subjected, and before the degraded matter was spread out to fill up the inequalities of the surface of the earth, we can see a probable cause for a commencement of what Newton calls "the evagation of the poles," and also the cause of a change in their position being again and again produced, until even the arctic regions may have been brought from a tropical position to their present position. We can see also how under the hypothesis there would be a gradual progress of a peculiar climate, arctic, or temperate, or tropical, over the surface of the earth, giving facilities to the spreading of a similar flora or fauna under the necessary conditions of light and heat for their development.

The solution of the difficult problem under consideration obviously turns upon the question of whether the geologist can show that such mountain masses may have been thrown up in former periods of the earth's history as would produce an "evagation" of the poles. I think we can; and that the changes of climate, the spreading of similar floras and faunas, and the undulations and dislocations of the strata composing the crust of the earth, are the necessary corollaries. A great number of other secondary minor forces, such as the eruption of igneous matter in different parts of the world, have, as is well known, been in operation to produce local changes; but the evagation of the poles is, as I think, the only cause of those great, widespread changes which have been adverted to.

The facts established by our geological investigations may be thus formulated:—

1st. We have evidence of great changes of climate in several successive periods, but with this peculiarity, that whilst the climate of the earliest periods was nearly uniform in all parts of the globe, this uniformity disappears in the more recent periods: the uniform character of the flora of the coal-measures is a proof of the one, and the very different character of the flora and fauna of the arctic, temperate, and tropical zones, marks the great change which has taken place.

Now these facts, if they stood alone, might be explained on the supposition that, from any cause whatever, the axis of the earth was at one time perpendicular to the plane of the ecliptic, and that its inclination was changed at the intervals which the changes of climate indicate until the axis reached its present inclination of twenty-three degrees thirty minutes.

With the axis perpendicular to the plane of the ecliptic, we should have at

each pole a circular area of from eighty to ninety miles upon which the sun would never set, and a much larger area within which, at the midnight of a very short night, there would always be the light and heat of summer twilight; whilst in all other parts of the earth there would be equal day and night, and no distinction of summer or winter, — a condition obviously favorable to the production of a very uniform flora; whilst at each of the supposed intervals of change, the long, cold arctic winters of the present time would be gradually introduced, with a corresponding change in the different regions of the earth.

2d. If these changes in the climate were the only facts to be accounted for, this supposed change in the direction of the axis of the earth would explain them, although we are unable to assign any cause for such a change.

But we have also to account for the fact, that the now cold, barren arctic regions had at one time the flora of a temperate climate, as in earlier periods it had that of a tropical climate. Again, we have proof that here in Great Britain, where we enjoy a temperate climate, we at one time had an arctic climate, and at another and earlier period a tropical climate; we can also prove that in certain parts of the present tropical regions there was formerly a temperate climate.

Now these facts cannot be explained on the first hypothesis; but they may be explained if we suppose that, instead of a simple change in the direction of the axis of the earth, the change was produced by the evagation of the poles — that is, that the north pole might at one time, for example, have been in the position of the magnetic pole, and that it has successively occupied several other positions till it reached its present position — and by the inclination of the axis being changed at each period.

Under this hypothesis we could explain the uniformity of the climate in the first period, the diversity of climate in the different regions of the earth as at present, and also the diversity of climate in the same parts of the earth in the intermediate periods.

3d. But if such changes have taken place in the position of the poles, and the earth has revolved in successive periods upon different axes, we ought to have evidence of great corresponding changes in the crust of the earth, arising from the movement of the protuberance of the equatorial regions into new positions corresponding to the movements of the poles.

Now, this is precisely what we do observe; for the crust of the earth is thrown into undulations or corrugations in lines parallel to the movements of the equatorial regions; that is, in lines either parallel to a great circle, or in lines analogous to loxodromic lines, or in curves such as would be produced if the poles travelled by a succession of movements along curved lines into their present positions.

The corrugations of the surface of the earth have, in fact, an arrangement something like the engine-turned lines upon the back of a watch; and there are particular sets of these corrugations corresponding to the epochs of those great changes in climate and organic life which have been referred to. Thus, for example, we have in this country the strata thrown into systems of undulation, which extend from Cape Wrath to the Ise of Wight; the undulations of the older strata being in the north in lines which cross the meridian at an angle of about forty-five degrees from northeast to southwest (that is, at right angles to a line drawn in the direction of the magnetic pole), and in the south in undulations running nearly east and west. Humboldt, in his *Essai sur le Gisement des Roches*, page 57, says: "The lines of direction of

the strata meet the meridians (when, for example, they are for great distances directed north forty-five degrees east) like the elements of a loxodromic line without being parallel in space. The direction of the ancient strata (primitive and transition) is not a small local phenomenon; it is, on the contrary, a phenomenon independent of the direction of the secondary chains, their branchings, and the sinuosities of their valleys, — a phenomenon the cause of which has acted uniformly for prodigious distances; as, for example, in the ancient continent between the parallels of forty-three and fifty-seven degrees north latitude, from the north of Scotland as far as the confines of Asia."

In the movements of the equatorial protuberance we have the only force adequate to produce such wide-spread effects as these, or the "slaty cleavage" in the same direction as the lines of the corrugations, or the great systems of "faults" which cross them, or those great systems of "joints" by which all the rocks composing the crust of the earth are divided into rhomboids, which, to repeat my former simile, are like the interstices between the lines on a watch. The great changes in climate and in organic life which occurred at periods corresponding to periods of great disturbance in the strata of the earth, and the several systems of lines into which the undulations of the strata are thrown, are all co-related phenomena, and no theory will be satisfactory that does not embrace them all as resulting from one and the same cause.

4th. We have now to consider whether the study of geology, which has brought to us the knowledge of these so remarkably co-related effects, does not also furnish us with data to enable us to trace the cause of them. I have already stated that we have in the mountain masses, which have been upheaved at different periods and in different parts of the earth, a sufficient cause for producing that evagation of the poles which Newton, before any of these geological facts were known, has said would necessarily result from their upheaval, and the evagation of the poles would produce the observed phenomena to which I have referred.

Since the commencement of my investigations on this subject, I have requested Captain Clarke, R. E., to be kind enough to undertake the mathematical investigation of this difficult problem, and the result he obtained leaves no doubt on my mind but that the evagation of the poles is the true cause of the change of climate, the corrugation of the surface of the earth, and the other phenomena adverted to.

To these powerful opponents, Colonel James finally replies, stating in the commencement his position anew, as follows: I have said that the elevation of mountain masses has produced an "evagation of the poles," which, as a consequence, has produced a change in the form of the earth, and corrugated and split up the strata composing its crust; and, further, that the extent of the evagation may have been such, that at one time the north pole may have been in such a position that the axis of the earth was perpendicular to the plane of her orbit (which it would be if the pole was nearly in the same position as the magnetic pole); and that at successive epochs it has occupied other positions, till it reached its present position, and caused the change of climate which distinguishes each epoch.

Putting the case in the most favorable form for producing the largest effect, and assuming that a mountain mass was equal to the $\frac{1}{1000}$th part of the mass of the equatorial protuberance, the result would be the shift of the poles of the earth to the extent of one or two miles; and in the case I have

supposed, viz., that the earth is not a rigid body, the first day's whirl would make the new position of the axis again a permanent position, — permanent, at least, until again disturbed by the upheaval of another mountain mass, capable of producing another change. I hope I have correctly represented what Mr. Airy admits, and that we have now got the problem into a form which will enable us very readily to discuss it.

And first, as to the magnitude of mountain masses as they now exist, I grant that there is no existing mass that can produce more than a scarcely appreciable change. But the present mountain masses represent but fragments of their former bulks. The great range of the Andes, with the whole continent of South America, is probably the most recently elevated mountain range upon the face of the earth; the whole has been raised to its present great height of about five miles within the most recent geological period, and the greater part of it has been raised several feet within our own time. And I know of no reason why it should not continue to rise until it reached a magnitude which would produce a sensible change in the position of the axis of the earth. But although it simplifies the conception of the problem to suppose the elevation of one mountain mass, we need not depend upon the elevation of one only for producing the effect; for if, with Sir C. Lyell, we suppose other configurations of the continents and seas, and that another great continent, with its mountain ranges, like the Himalayas, rose simultaneously with South America at the other side of the globe, whilst other lands in opposite directions are sinking, it is obvious that under this supposition the effect might be quadrupled.

But, it may be asked, can this elevation of mountain masses be supposed to continue to proceed to an indefinite extent? Certainly not; their attaining a certain magnitude would lead to results which would rapidly produce the reduction of their bulk, if it did not sweep them away altogether.

The great geological epochs of which we have been treating are separated by intervals of what may be called the periods of tranquil deposition of nearly horizontal strata, and those periods of disturbance during which the strata have been thrown into great systems of undulations, and whole races of animals and plants utterly and simultaneously annihilated over the whole world, and the climate changed for the succeeding period of tranquillity.

These tranquil periods have been of such long duration, that no geologist ventures to say what number of years they occupied: a period of millions of years ago is but as yesterday in geological chronology, and the vast periods of time required for mountains to attain a magnitude sufficient to disturb this state of tranquillity is necessary to, and consistent with, the hypothesis.

We must not investigate this problem, therefore, under the supposition that vast mountain masses have suddenly made their appearance in any given positions. Their increase, as measured by the chronology of man, is so slow that we could not possibly expect that astronomical observation could detect the effect of the increase in their magnitude in disturbing the position of the axis of the earth. The effect of this slow increase may, by a rough analogy, be compared with that which takes place when the base of a great iceberg is slowly dissolved, until eventually the whole mass gives a roll, and settles into a new position of equilibrium.

Let us suppose that a mountain mass may possibly have attained to the required magnitude to produce the change, and that at the critical period or

turning-point in its history the earth gives a sudden whirl, and assumes a new position. We must first endeavor to imagine what would be the effect upon the strata composing the crust of the earth consequent upon the movement of the protuberant equatorial mass; the strata would be thrown into undulations in quasi-loxodromic lines, such as have been described by Humboldt and others.

And what we must next inquire would be the effect upon the great volume of water in the seas in which the strata were being deposited. The water would be thrown with irresistible violence upon the continents, whole races of animals and plants would be simultaneously destroyed, and the surface of the earth ground down by the water itself, and the forcing along of vast masses of detrital matter over it; and finally there would be such a change, be it small or great, in the position of the poles of the earth, and in the inclination of its axis, as would produce a change of climate in every part of the world, but more marked in the arctic and temperate regions than the tropical. We have but to suppose this repeated again and again to account for all the observed phenomena.

In weighing the probability of the truth of this theory, we must take into consideration the fact, that no other theory has been before advanced which would account for these so intimately correlated phenomena being produced by one and the same cause; and I still hope that some at least of my scientific friends will admit that I have given them in it a valuable "wrinkle."

In opposition to these views of Sir Henry James, Mr. Jukes, one of the directors of the Geological Survey of Great Britain, publishes the following communication in the *Athenæum*, under date of September 3d, 1860. He says: —

In the first place, I would object that there is no proof that "there has been everywhere a change of climate;" since the tropical and sub-tropical portions of the earth's surface may have always had pretty much the same mean temperature which they have now, for everything we can show to the contrary. It is, indeed, almost certain that the arctic and northern temperate regions were once warmer than they are now, and that warmer climate seems to have endured for all geological time until a very recent geological period. It is equally certain that large parts at least, if not the whole (there is some doubt as to that), of the northern temperate regions were, during that recent geological period, considerably colder than they are now. This colder climate seems, during that same period, to have prevailed as far south as Northern India, judging from the former greater extension of the glaciers of the Himalaya, as described by Dr. Hooker and others, though possibly that might admit of explanation on the supposition of greater moisture there, caused by the Bay of Bengal extending up the present valley of the Ganges. We have, however, no reason to look to any other spot on the globe than the present north pole as the centre of that cold climate during this glacial or pleistocene period. Neither has any one yet ventured to point to any other region of the globe as having been possibly its arctic region during any previous geological period, — basing his argument on the fossils of that region having a more arctic character than the contemporaneous fossils of surrounding countries.

The change of climate seems, as far as we can judge, to have been a general change from an "insular" to a "continental" climate, or, in other words, a change from one where a milder temperature was more widely diffused over

the globe, to one in which the local distribution of heat was more marked and the climate more "excessive," the mean temperature of the polar regions becoming certainly less, and possibly that of the equatorial regions rather greater, than before. It is obvious that such a change is one that cannot be accounted for by any shifting of the earth's axis.

But even if we dismiss palæontological arguments, and look solely to the form of the earth, it seems to me that we have good reason to doubt the possibility of a change in the earth's axis of rotation. Admitting the assumption adopted by Sir Henry, that the earth was at first a fluid mass, and afterwards a mass with a hardened crust, it follows that, if it rotated with the same velocity as now, the oblateness of its spheroid must have been originally as great as it is now. That oblateness may be conceived thus: If we imagine a perfect sphere to be described about the centre of the earth, with the distance from the centre to the poles as its radius, the surface of that sphere would coincide with the earth's surface about the poles, but would sink regularly as we receded from them, until it reached a depth of about thirteen and a quarter miles at the equator. The earth must have had then, *ab initio*, a protuberant shell, gradually bulging beyond the form of a true sphere, till it reached to the extent of thirteen and a quarter miles, or nearly seventy thousand feet, about its equator. It is very difficult to see what force, internal or external, could have given to a globe thus weighted and balanced all round such a permanent tilt as would cause it to spin on any other than its shortest diameter, or could so alter its form as to make any other diameter shorter than its original axis of rotation. The highest mountain in the world, Mount Everest, is only five and a half miles high, one-third of that height being a mere pinnacle. The table-land of Thibet, with the Kouenlun and Himalaya mountains, is certainly the largest projecting mass above the surface of the earth; but its mean height cannot be greater than two and a half miles, and its greatest diameter is only some six or seven hundred miles. Its mass, therefore, can bear but a very small proportion to the mass of the protuberant belt surrounding the earth in its latitude, and still less to the whole protuberant shell, and can, therefore, have but an equally slight influence in overcoming the effect of that shell in giving equilibrium to the earth's motion. If the much greater irregularities in the earth's surface, namely, those prominences which form the masses of dry land, and those hollows in which the ocean lies, be wholly within the protuberant shell of the earth,—and I think that we can have no doubt that they are so, except in the immediate neighborhood of the poles,—and if these great irregularities balance each other, and the equilibrium of the earth be maintained, it appears to me that the addition or subtraction of a mere wrinkle such as the Alps, the Andes, or the Himalayas, could hardly have more than an infinitesimal effect on that equilibrium. But the nearer the irregularities are to the pole, the less would be their disturbing effect, so that high land or deep sea there (and the Arctic Sea, at all events, seems comparatively shallow) would have less effect than in lower latitudes, while exactly as the latitude decreases the compensating protuberance increases.

Sir Henry assumes that our present mountain chains were once much greater than they are now, because such vast masses of rock have been removed from above those of which the present mountains are composed. I fully agree with him in the vast amount of erosion and denudation that has taken place over all our mountain chains; but, then, I believe that erosion was caused by the wearing action of the sea as the mountains slowly

rose through the destructive plane of the sea-level, both on their first emergence and at subsequent periods, when, after depression, they have had again to rise through that level. However great may have been the removal of rock, therefore, from over what are now the crests of our mountains, it does not follow that the mountains were ever materially loftier than they are now. Not only were those vast sheets of rock removed by the action of the sea, but the gaps and passes that indent the summits of mountains, as well as many of the glens, ravines, and valleys that furrow their sides, were evidently commenced by the same action, though I am quite willing to believe that atmospheric agency has deepened and widened, and sometimes produced, these to a much greater extent than is commonly supposed.

We certainly could not have any example of the elevation of a mountain chain during historic times if, as I am fully convinced, any mountain chain requires, not thousands, but millions, and even hundreds of millions, of years for its elaboration. Sir C. Lyell has given us abundant proof that the two actions of elevation and denudation, by which mountain chains have been produced, are still going on with as much vigor and intensity as they ever were.

Furthermore, I would observe that while admiring the ingenuity of Sir Henry's application of the hypothesis he favors to the production of such structures as "faults" and "cleavage," there does not appear to be the slightest necessity to evoke such a "*deus ex machinâ*" as a shift of the earth's axis for the purpose, since they might all be caused by the local movements which now take place, and seem always to have been taking place, in different parts of the earth's crust.

Lastly, there is not any good evidence in favor of the supposition that periods of tranquil deposition and periods of disturbance were ever common to the whole globe. On the contrary, everything is in favor of the belief that, during all geological time, tranquillity and disturbance have always been simultaneous in different parts of the globe, just as they are now.

That "whole races of animals and plants" have ever been "utterly and entirely annihilated over the whole world," is a gratuitous supposition taken up at one time by geologists from want of proper consideration of the facts of the case. They unconsciously assumed a continuity of succession in the deposition of the groups of strata which can never be proved, though, in many instances, it can be disproved by evidence independent of the fossils. I have often discussed this question with the late Edward Forbes and others, and have arrived with them at the firm conviction that the change in the forms of life inhabiting the globe may have always been as slow and gradual as it has been during the historic period. We know that some species have become extinct, not only for particular localities, but for the whole world, even within the last few centuries. The introduction of new forms may have been just as gradual. The appearance of sudden changes in the fossils found in a vertical succession of beds is due to the fact of our having one group of beds deposited during the middle, or end perhaps, of one great geological period, resting directly on the undisturbed surfaces of another group of beds belonging to some anterior period; nothing having been deposited in that locality during the whole vast interval by which its lapse could be recognized.

My friend Sir Henry refers the production of the corrugation of the strata, and that of the joints, faults, and cleavage, which traverse them, to the shifting of the protuberant mass of the globe, and says that that shifting is

produced by the elevation of mountain chains. But, as a matter of fact, every mountain chain can be shown to be accompanied by corrugated strata and faults, and sometimes by cleavage, and even, perhaps, by systems of joints, in such a way as to show that all these structures were produced by the elevation of the mountain chain, or, rather, that that elevation and all the other phenomena were the simultaneous results of the same disturbing action. The influence of this action may sometimes be traced to considerable distances into the lower lands on each side of the mountain chain, gradually fading away as we recede from it, so as to show that the mountain chain was raised over the line of greatest intensity and largest endurance of a comparatively widely spread disturbing force, which, nevertheless, was limited to a certain part of the crust of the globe.

It appears to me, then, that, to be strictly consistent, Sir Henry should refer the elevation of mountain chains themselves to the slow and gradual shifting of the earth's axis and its protuberant equatorial mass; but then, in that case, where are we to seek for the cause of this shifting?

The views of Sir Henry James have also called forth the Astronomer Royal of Great Britain, Professor Airy, in an article, in which, while admitting the accuracy of the principle invoked by Colonel James, he doubts the adequacy of the cause, in magnitude, to explain the supposed effect. Professor Hennesey, of Dublin, also publishes an article in which he supports the views of Professor Airy.

ON THE GRADUAL PASSAGE OF THE DEVONIAN SYSTEM INTO THE CARBONIFEROUS.

The following is an abstract of some remarks made before the Boston Society of Natural History, by Professor W. B. Rogers, on the occasion of the presentation of a paper by Mr. C. A. White, showing the gradual passage of a Devonian into a Carboniferous fauna, in the rocks of these two systems in the State of Iowa:—

Professor Rogers considered such a gradational change, or such a mingling of races in successive formations, as but the natural result of the accumulation of the strata during a long period of comparative repose. He believed that the abrupt transitions so often observed in passing from one geological formation to another were not, as some maintain, an essential feature in the life-history of our earth, but were the memorials of the disturbing and destroying agencies to which its living races had been successively exposed. These hostile influences have at no time been of equal intensity over widely extended areas, but, varying from region to region, have in some places arrested only in part the stream of living descent; thus substituting for the abrupt transition which marks the successive faunæ of one district the gentle gradations and intermingling of forms presented by the corresponding deposits of another.

Referring even to the limits of the great paleozoic divisions, so often defined by sharp lines of separation, observation has shown that in some localities the transition is so gradual as to present no greater amount of change in fossil forms than occurs in passing from one subordinate formation to the next. Hence we find that the ablest European geologists are not agreed as to the line of separation between the Silurian and Devonian, or between the latter and the Carboniferous deposits of some of their best-known districts; while recent observations in this country and abroad have

tended to obliterate the presumed line of demarcation between the Carboniferous and overlying Permian strata, wherever the transition beds are most completely developed.

As regards the passage from the Devonian to the Carboniferous series, Professor Rogers remarked that the observations of Mr. White on the Burlington strata had their counterpart in those of Griffith, Jukes, McCoy, and other Irish geologists, who have been led to include in the lower Carboniferous series of Ireland a thick group of deposits which Murchison and others place in the Devonian. Indeed, according to McCoy's determinations, the Carboniferous limestone of Ireland contains among its fossils quite a number of forms identical with those of the Devonian rocks, as well as many that belong also to the Upper Silurian.

These facts and considerations lend support to the view that the changes of fossil faunæ are more gradual in proportion to the degree in which the successive deposits of a given period have been preserved from destruction, and certainly favor the doctrine of a gradational continuity in the succession of living races rather than that of sudden underived creations.

Looking to the question of the equivalency in time of the rocks described in Mr. White's paper with deposits in the eastern and southeastern parts of the Appalachian basin, we are struck with the enormous thickness of the several groups of strata in the latter region, which find a representation, as to period, in the inconsiderable mass of calcareous and other beds, occupying, in this western locality, the interval between rocks of unequivocally Devonian and Carboniferous ages. In this part of the Appalachian area, the interval referred to includes not only the vast thickness of red and variegated strata of the Ponent or Catskill series, but in Pennsylvania and Virginia a great mass of conglomerate, sandstone, and shale, containing in some districts considerable seams of coal, the whole attaining in places an aggregate thickness of more than six thousand feet. This latter, or Vespertine series, maintaining a position always below the shales and limestones charged with *Archimedes* (*Fenestella*) *Pentremites*, and other carboniferous limestone fossils, and forming a lower carboniferous group corresponding to that of Scotland and Nova Scotia, may perhaps claim a place on the same time-level with the portion of the Burlington group in which the carboniferous forms have assumed predominance, or may extend in period as far as the lower Archimedes or Keokuk limestone.

But all such attempts at synchronizing distant deposits must be limited to a general and vague result. Even when corresponding fossils would seem to mark a simultaneous origin, we must not forget the large agency of migration, and the long lapse of years which in many cases may have been required for the extension of a living race into distant submarine settlements.

ON THE SYNCHRONISM OF THE COAL-BEDS OF NEW ENGLAND AND THE WESTERN STATES.

The following paper was read at the American Association, 1860, by Professor C. H. Hitchcock, of Amherst, Mass.: —

A few years ago, no one thought it possible to identify any particular bed, or series of beds, of coal in the carboniferous system by means of peculiar or characteristic fossils. But now, thanks to several observers and collectors, chief of whom is Leo Lesquereux, of Columbus, Ohio, most of the beds of

coal have been found to be distinguished from one another by the peculiar forms of vegetation associated with them. Each series of beds has associated with it either characteristic species of plants, or, more usually, different species, common to several series of beds, but grouped together in a peculiar way.

In the Appalachian and the Western coal-fields the synchronism of the different beds has been largely ascertained, and the equivalency is satisfactory.

The equivalency of the New England beds of coal with the others has never till now been ascertained. We have made collections of plants from several localities in the New England basin, and Mr. Lesquereux finds that their distribution corresponds to that of the beds in the other basins. The localities examined are in Wrentham, Mass., Valley Falls, Portsmouth, and Newport, R. I.

From Wrentham the following species were obtained: *Asterophyllites lanceolata, Lesqx., A equisetiformis, Brgt., Annularia longifolia, Brgt., Sphenophyllum Schlotheimii, Brgt., Calamites Suckowii, Brgt., C. Cistii, Brgt., Neuropteris flexuosa, Brgt., N. hirsuta, Lesqx., N. Loschii, Brgt., Alethopteris Pennsylvanica, Lesqx., A. nervosa, Gopp., Pecopteris Mitoni, Brgt., P. arborescens, Brgt., Sphenopteris abbreviata, Lesqx., Lepidophyllum*, nov. sp., *Trigonocarpum*, nov. sp. Lesquereux says of the locality of these plants: "The exact geological horizon of the shales where these species of fossil plants have been collected is obvious, not only from the species themselves, but also from their relation in number to each other. It corresponds with the shales covering over No. 3 coal of the Western sections of the coal measures, equivalent of coal D. (Lower Freeport) of J. P. Lesley's 'Manual of Coal.'

"The exact counterpart of your shales (or exact likeness) is found especially at both the Salem beds of Pottsville, at W. W. Wood, Port Carbon, and many other places of the anthracite basins of Pennsylvania; and in the Western coal measures, in Kentucky, along the Tug river (separating Kentucky from Virginia), in Greenup, Lawrence, Breathitt counties, etc. In the Western coal-fields of Kentucky and of Illinois, this bed is frequently found with the same fossils, and it is one of the best and most reliable for its coal. In the East, this bed is generally separated into two or three different beds by clay partings of various thicknesses, each bed of clay containing the same or nearly the same plants. It often runs to No. 4, from which in the Western coal-fields it is separated by a limestone, and to which it is related by its vegetation, or the ferns."

These shales in Wrentham lie above a bed of coal which has been worked, at least a hundred feet; and probably the bed which was worked in Mansfield and other adjacent towns is at the same geological horizon. The plants from these beds were not examined, but the probability is, as suggested by Lesquereux before he knew of its relative position, that this workable bed is the equivalent of No. 1 B, the big or mammoth coal bed of the East. This is confirmed by the early discovery of stigmariæ at the lower Wrentham bed, and in Mansfield.

The general position of the Valley Falls bed is the same with that just described. We did not obtain a sufficient number of plants from its shales to authorize a certain conclusion from them.

We have made a careful examination of the island of Rhode Island, particularly its southern part, and the following is the order of strata, commencing at the base of the carboniferous system and proceeding upwards:

Coarse conglomerate containing elongated pebbles, 500 feet; slates, shales, etc., 470 feet; conglomerate, 464 feet; measures concealed, 920 feet. Just above these concealed measures we collected specimens of *Pecopoteris affinis, Brgt.* (never before found in America), *P. arborescens, Brgt., P. unita, Brgt., Asterophyllites sublaevis, Lesqx., Annularia sphenophylloides, Brgt., Aphlebia,* nov. sp., *Sphenophyllum emarginatum, Brgt., S. Schlotheimii, Sternb., Sphenopteris,* nov. sp., and *Annularia fertilis, Sternb.*

Passing over about 250 feet thickness of slate, sandstones, and conglomerates, we next come to shales associated with numerous small beds of anthracite, and containing *Pecopteris nervosa, Brgt.* Seventy-five feet higher in the series are twenty-five feet thickness of carboniferous shales containing the *Alethopteris Pluckneti, Brgt.,* and *Neuropteris tenuifolia, Brgt.* The most productive bed of plants is two feet thick, and is seventy feet higher yet. It contains *Asterophyllites sublaevis, Lesqx., Pecopteris arborescens, Brgt., Annularia fertilis, Sternb., Neuropteris,* nov. sp., allied to *N. Grangeri, Brgt., Lepidodendron, Pecopteris unita, Brgt., P. dentata, Brgt., P. cyathea (?), Brgt., Sphenopteris elegans, Brgt., Annularia sphenophylloides, Brgt., Sphenophyllum Schlotheimii, Sternb., Cyclopteris,* nov. sp., *Lepidodendron dichotomum, Sternb., Sphenopteris intermedia, Lesqx., Pecopteris arguta, Brgt., P. oreopteridius, Brgt.,* and two indeterminable species of *Pecopteris.* This latter group corresponds to the plants found at the South Salem beds of Pottsville, or the upper part of No. 3 coal. The Wrentham specimens in distinction from them are from the North Salem bed at Pottsville, or the lower part of No. 3 coal.

The next five hundred feet of coal measures are mostly concealed by soil. A few seams of coal have been discovered in them, which may correspond with coal No. 4, as it overlies the plants of No. 3 coal. A few species of plants, which are not distinctive, have been found at the top of these five hundred feet of strata, immediately underlying a conglomerate of fifty feet or more thickness, whose positions correspond stratigraphically with the the Mahoning sandstone of the West. Above this conglomerate there are 1,320 feet thickness of coal measures in the town of Newport, in which no seams of coal have ever been discovered. This may be due to the fact of the complete alteration of these measures by metamorphic agency into silicious slate, jasper, chert, serpentine, dolomite, and granite. The dolomite is in two beds, one forty-five and the other sixty-five feet wide. The total thickness of the whole system at Newport is 6497 feet.

In the north part of Portsmouth are the only beds of coal that are worked upon the whole basin, — at the Aquidneck mine. In the vicinity of this mine there are *eleven* different beds of coal. Above the beds worked for coal three seams of coal have been found, and there are six below. From the shale at the mine the following species of plants have been obtained: *Annularia fertilis, Sternb., Odontopteris Beardii, Brgt., Neuropteris,* nov. sp., related to *N. Grangeri, Brgt., Pecopteris arborescens, Brgt., Sphenopteris Gravenhorstii, Brgt.,* and several others, not yet examined by Lesquereux. These are the plants peculiar to the Lower or North Salem bed at Pottsville.

Thus all the beds of coal and shales containing plants which we have examined in the New England coal basin belong to the lower coals, and also to the lower parts of the lower coals, since they all lie below the Mahoning sandstone. Beds of coal (perhaps series of small beds) are found, equivalent to the Pomeroy, South Salem, North Salem, and Mammoth beds, in other coal basins. We think it doubtful whether the beds of the upper coal measures of other basins are to be found in the New England coal field, partly

from metamorphism, partly from denudation, or perhaps they may never have been deposited.

Mr. Lesquereux compares the New England basin with the others as follows: "From your very interesting section of Aquidneck Island, it appears that near or at the western limits of the coal fields of North America the multiplication of conglomerate strata analogous to that which is found in Nova Scotia is already evident. Thus your coal fields of Massachusetts and Rhode Island look as forming a link of transition between the coal basin of the Great Appalachian and Western region, and that of Nova Scotia. Indeed, the difference is easily marked and understood. To the eastward, the sandstones, conglomerates, or *shore materials*, predominate; to the westward, on the contrary, the limestone and marine formation becomes more marked. It is the only difference."

ON THE GEOLOGY OF NEBRASKA.

At a recent meeting of the American Philosophical Society, Professor Leidy gave the following account of the geology of the Territory of Nebraska:—

This great territory, embracing upwards of one hundred and thirty thousand square miles, is composed of formations of the cretaceous and later tertiary periods, with here and there a protrusion of metamorphic rocks. Watered by the many western tributaries of the Missouri, almost all of these, so far as they have been explored, have yielded large numbers of species of extinct organic forms, vegetable and animal.

From the Mauvaises Terres of White river, a miocene tertiary fresh-water formation, apparently a lacustrine deposit, an immense quantity of fossil bones of extinct mammals and turtles have been collected. In collections made by gentlemen of the Fur Company, by Jesuit missionaries, by Dr. Hayden, and in others obtained under the auspices of the government, the Smithsonian Institution, and Professor James Hall, altogether forming from six to eight thousand pounds of fossils, submitted to Dr. Leidy's inspection, he had detected the remains of thirty extinct mammals, and one turtle. Of these there are ten species of the extinct genera of *ruminants*, *Oreodon*, *Agriochœrus*, *Poebro-therium*, *Dorca-therium*, *Leptauchenia*, and *Protomeryx*; eight species of *pachyderms* of the genera *Hyopotamus*, *Elotherium*, *Titanotherium*, *Palœochoerus*, *Leptochœrus*, *Hyracodon*, and *Rhinoceros*; of *solipeds*, a species of *Anchitherium*; of *rodents*, four species of the genera *Chalicomys*, *Ischyromys*, *Palœolagus*, and *Eumys*; of *carnivora*, seven species of the genera *Hyœnodon*, *Amphicyon*, *Drepanodon*,[1] and *Deinictis*; and the turtle forms the extinct genus *Stylemys*.

From a later tertiary formation than the one just indicated, and suspected to be of pleiocene age, on the Neobrara river, explored in the recent expedition of Lieutenant G. K. Warren to Nebraska, Dr. Hayden, geologist to the expedition, collected a large quantity of fossil bones. These are of

1 The name *Drepanodon* was applied by Nesti, as early as 1826, to the sabre-toothed tiger, for which, subsequently, a number of other names have been employed, that of *Machairodus* of Kamp being the most familiar. The author of the above remarks applied the name *Drepanodon*, in 1856, to an extinct reptile or fish, a tooth of which was discovered by Professor E. Emmons, at Cape Fear, N. C. The author would now substitute the name *Lesticodus impar*, *Leidy*, for the animal.

especial interest as indicating a fauna more nearly allied to the existing fauna of Asia and Africa than to our own. In the collection submitted to the examination of Dr. Leidy, he detected the remains of twenty-nine mammals and one turtle. Of these there are ten species of *ruminants* of the genera *Cervus, Merycodus, Procamelus, Megalomeryx, Merycochœrus,* and *Merychyus;* three *pachyderms* of the genera *Rhinoceros, Mastodon,* and *Elephas;* of *solipeds,* eight species of the genera *Equus, Hipparion, Protohippus, Hypohippus, Parahippus,* and *Merychippus;* of *rodents,* two species of the genera *Hystrix* and *Castor;* of *carnivora,* six species of the genera *Canis, Felis,* and *Aelurodon;* and the turtle appears to be a species of *Stylemys.*

From the greensand formation of the cretaceous period, through which course the Missouri and its tributaries, the Grand, Moreau, and Cheyenne rivers, with a part of White river, the remains of numerous species of molluscs have been obtained. From this formation it was that Maximilian, Prince of Neuwied, obtained the skull and vertebral column of *Mososaurus Missouriensis,* described by Dr. Goldfusz, and now preserved in the Museum of Bonn. Teeth of sharks and remains of sphyraenoid fishes have also been discovered in the same formation.

ON THE DRIFT OF THE TRIASSIC EPOCH.

The following is an abstract of a paper read before the British Association, 1860, by Mr. C. Moore, which attracted no little attention: —

The author stated that several years ago he suspected the existence of triassic rocks in the neighborhood of Frome (England), from accidentally finding a single block of stone on a road-side heap of carboniferous limestone, containing fish remains of a former age, but that for a long time he was unable to discover it *in situ.* More recently, when examining some carboniferous limestone quarries near the above town, he observed certain fissures which had subsequently been filled up with a drift of a later age. One of these was about a foot in breadth at the top, but increased to fifteen feet in breadth at the base of the quarry, thirty feet below, at which point teeth and bones of triassic reptiles and fishes were found. Usually these infillings consisted of a material as dense as the limestone itself, and from which any organic remains could only be extracted with difficulty. In another part of the section he was fortunate enough to find a deposit consisting of a coarse, friable sand, containing similar remains. In order that this might receive a more careful examination than could be given to it on the spot, the whole of it, consisting of about three tons weight, was carted away to the residence of the author, at Bath, a distance of twenty miles, all of which had passed under his observation, with the following result: The fish remains, which were the most abundant, were first noticed. Some idea might be formed of their numbers when he stated that of the genus *Acrodus* alone, including two species, he had extracted forty-five thousand teeth from the three square yards of earth under notice, and that they were even more numerous than these numbers indicated, since he rejected all but the most perfect examples. Teeth of the *Saurichthys* of several species were also abundant; and, next to them, teeth of the *Hybodus,* with occasional spines of the latter genus. Scales of the *Gyrolepsis* and *Lepidotus* were also numerous, and teeth showing the presence of several other genera of fishes. With the above were found a number of curious bodies, each of which was surmounted by a depressed, enamelled, thorn-like spine or tooth, in some cases with

points as sharp as that of a coarse needle; these the author supposed to be spinous scales belonging to several new species of fish, allied to the *Squaloraia*, and that to the same genus were to be referred a number of hair-like spines with flattened fluted sides found in the same deposit. There were also present specimens hitherto supposed to be teeth, and for which Agassiz had created the genus *Ctenoptychius*, but which he was rather disposed to consider, like those previously referred to, to be the outer scales of a fish allied to the squaloraia. It was remarked that, as the drift must have been transported from some distance, delicate organisms could scarcely have been expected; but, notwithstanding, it contained some most minute fish-jaws and palates, of which the author had, either perfect or otherwise, one hundred and thirty examples. These were from a quarter to the eighth of an inch in length, and within this small compass he possessed specimens with from thirty to forty teeth; and in one palate he had succeeded in reckoning as many as seventy-four teeth in position, and there were spaces where sixteen more had disappeared; so that, in this tiny specimen, there were ninety teeth. Of the order *reptilia* there were probably eight or nine genera, consisting of detached teeth, scales, vertebræ and ribs, and articulated bones. Amongst these he had found the flat crushing teeth of the *Placodus*, a discovery of interest, for hitherto this reptile had only been found in the muschelkalk of Germany, — a zone of rocks hitherto wanting in Great Britain, but which in its fauna was represented by the above reptile. But by far the most important remains in the deposit were indications of the existence of triassic mammalia. Two little teeth of the *Microlestes* had some years before been found in Germany, and were the only traces of this high order in beds older than the Stonesfield slate. The author's minute researches had brought to light fifteen molar teeth, either identical with, or allied to, the *Microlestes*, and also five incisor teeth, evidently belonging to more than one species. A very small double-fanged tooth, not unlike the oölitic *Spalacotherium*, proved the presence of another genus, and a fragment of a tooth, consisting of a single fang, with a small portion of the crown attached, a third genus, larger in size than the *Microlestes*. Three vertebræ, belonging to an animal smaller than any existing mammal, had also been found. The author inferred that if twenty-five teeth and vertebræ, belonging to three or four genera of mammalia, were to be found within the space occupied by three square yards of earth, that portion of the globe which was then dry land, and from whence the material was in part derived, was probably inhabited at this early period of its history by many genera of mammalia, and would serve to encourage a hope that this family might yet be found in beds of even a more remote age.

OBSERVATIONS ON THE ACCUMULATION AND DEPOSITION OF SEDIMENTARY MATTER.

At a recent meeting of the Boston Society of Natural History, Professor W. B. Rogers exhibited a fossil cast in sandstone of part of the trunk of a large Sigillaria, from the South Joggins, in Nova Scotia, where, as first shown by Logan and Dawson, these and other stems belonging to the carboniferous age occur at numerous levels in the strata, and are to be seen standing in the erect position in which they grew.

In considering the process by which these stems were originally enveloped by the mass of sediment now enclosing them, in the shape of sandstone and

shale, an inquiry of much interest is suggested as to the rate of accumulation of the deposit in which they are buried. Many of these erect trunks are of very considerable height, and one is mentioned by Sir Charles Lyell as traceable vertically across the strata for a distance of twenty-five feet. In all such cases the decay of the tree could have made no great progress before the trunk became buried to the whole observed depth, otherwise it would have become too weak to maintain an erect position, and must have fallen over. We infer, therefore, that the mass of sediment, even to the height of twenty-five feet, in the case above cited, must have been accumulated around the stem in a period extending at farthest only to the earlier stages of change in the organic structure. Moreover, this conclusion is strongly confirmed by the fact that the peculiar markings of the outer wood, and even of the bark, are often found impressed so distinctly on these erect sandstone casts as to afford a means of discriminating the character of the plant.

It seems, therefore, undeniable that in these cases the mass of sediment, amounting sometimes to twenty-five feet, was accumulated around the standing tree in a very short time, a mere moment as compared with the units according to which geologists are accustomed to reckon the growth of such deposits, in the usual way of sedimentary accumulation. Yet a little consideration will show that facts of this kind furnish no support to the opinion of those whose imperfect acquaintance with geological data has led them to deny the necessity of prolonged cycles of formative action in the production of the great systems of sedimentary strata.

In explaining the rapid entombment of the trees in their vertical position, it should be borne in mind that there are two processes very distinct from each other by which sediment may be accumulated over a given area. One of these is the series of actions by which the materials of preëxisting rocks, worn down and diffused by tides and currents, are deposited more or less equally over wide regions, so as to build up, step by step, a newer system of formations. The other consists in the transfer of sediment already accumulated from one part of the bed of the sea or estuary to a neighboring one. In the former process it would seem clear, from all the geological data, that vast periods of time must have been consumed. The latter, being nothing more than the sweeping of soft sand and mud from one submerged area to another in its vicinity, would require no other agency than some unusual local disturbance of the waters, such as might result from earthquakes or great inundations, and would demand but a short time for its completion. In this view, the thick mass of sandstone and shale enclosing the erect trunk of the fossil tree, although accumulated at this particular part of the carboniferous area in a very short time, is not to be regarded as simply the product and measure of this brief geological moment. Considered in relation to its previous history in the carboniferous period, it rather represents the comparatively long series of combined actions which brought its materials into suspension in the waters, and gradually deposited them over the area, from which they were afterward so rapidly removed.

In framing any conjecture as to the length of time corresponding to the formation of a group of strata at any particular locality, as the Joggins, we would, of course, ascribe but a small value in years to such masses of deposit as thus prove themselves to have been hastily accumulated at the spot where they are found. But, on the other hand, we should be careful not to apply the same measure of rapid accretion to those associated beds of shale, limestone, coal, and even sandstone, which give intrinsic evidence of having been

tranquilly and slowly deposited. We should also keep in view the important fact, that while one part of the column of strata whose chronology we are studying has been thus rapidly built up by the materials swept into it from a neighboring quarter, other parts of the same column have been reduced in thickness, or even wholly removed, by similar local actions in the opposite direction; and that therefore the strata as they stand give us the measure of a time much less than that in which, as a group, they were actually deposited.

GEOLOGICAL SUMMARY.

Tin Ore in California. — Dr. C. T. Jackson, of Boston, in a note to the editor of the *Mining Journal*, says: —

"In July, 1859, I received among a lot of ores, brought me under the supposition that they were of silver, a very rich tin ore, containing sixty and a half per cent of metallic tin in the state of oxide of tin, mostly amorphous, and mixed with brown oxide of iron. It is a curious ore, and would, were it not for its great density, be mistaken for an ore of iron. It was found near Los Angelos, California. The vein is said to be six or eight feet wide. This I think must be an exaggeration; but it is certainly eight inches wide, as shown by the size of the specimens sent to the Revere Copper Company, in Boston, most of which Mr. Alger obtained for his cabinet, and for the manufacture of some samples of metallic tin, which he has smelted and refined at a brass-foundery, and got forty per cent of refined tin." We understand that parties have gone to California to make arrangements for opening and working this vein.

New Mineral containing Boracic Acid. — At a recent meeting of the Boston Society of Natural History, Dr. A. A. Hayes exhibited a very fusible white mineral from Lake Superior, containing twenty-two and a half per cent of boracic acid; it was a silicate and borate of lime, and was obtained from the region of the Minnesota copper mine. Dr. Hayes stated that if this mineral was abundant, it might be collected with commercial advantage.

Dr. Kneeland observed that the same substance is abundant in the Portage Lake region, and exhibited from the cabinet of the Society a large specimen obtained by him from the Isle Royale mine.

Devonian Rocks and Fossils in Wisconsin. — A private communication to the editor of the *American Journal of Science* states that Mr. J. A. Lapham has recently announced the discovery of rocks near Milwaukie equivalent to the Devonian, and containing remains of characteristic fishes. These remains consist of fragments of bone, teeth, a paddle, with portions of the tuberculated skin or osseous covering. The bed containing these remains overlies the Niagara group, and is the uppermost of the geological series yet observed in Wisconsin.

Flora of the Older Palæozoic Rocks. — M. Goeppert, the German naturalist, states that the flora of the Silurian, Devonian, and lower Carboniferous deposits comprise one hundred and eighty-four species of plants, including thirty different kinds of algæ. Paleontologists have heretofore supposed the number to be much less.

Fossil Eggs from the Oölite. — At a recent meeting of the Royal Geological Society (England), Professor Buckman called attention to the discovery of a group of fossil reptilian eggs in a block of oölitic limestones from a quarry near Cirencester, England. The petrified turtle-eggs from the coral-sands of the Pacific, those of crocodiles in the West Indies, and those of snakes

in the fresh-water limestones of Germany, prepare the geologist for the occurrence of fossil reptilian eggs in the oölitic limestones, which are often similar to the coral-sands of our present seas.

Motion of Glaciers. — The results of an expedition to the Alps, in the winter of 1859, by Professor Tyndall, of London, have been published during the past year. He remained two nights at Montanvert, and determined with a theodolite the motion of the Mer-de-Glace, and found it to be about one-half of its summer's motion. Crystals of snow fell almost without intermission during the progress of the measurements. He afterwards visited the vault of the Aveiron, and found a turbid stream issuing from it, indicating that even in winter the motion of the glacier along its bed, by which the rocks over which it passes are ground, is never suspended.

PETROLEUM OR ROCK OIL WELLS.

Considerable excitement has been occasioned during the past year by the obtaining of large supplies of Petroleum, or, as it is commonly called, "Rock Oil," in Northern Pennsylvania, and the application of the same to commercial purposes. The yield of some of the wells which have been opened by boring is very remarkable. At Oil Creek, Venango County, Pennsylvania, single wells are reported to have yielded from four hundred to eight hundred or even one thousand gallons daily. In some instances the oil overflows from the opening of the well spontaneously, but in most cases it is obtained by pumping. The crude oil burns dimly, and is a very good lubricator, but when refined it has little smoke or odor, and in illuminating qualities equals the best coal-oils. Its price at the wells of Pennsylvania is about twenty cents per gallon, and it is estimated that from twenty thousand to thirty thousand barrels have been afforded by the State of Pennsylvania during the past year. Near Pittsburg there are several oil wells, which yield a supply nearly sufficient to employ two works in refining it. At Petroleum, on the Northwestern Railroad of Virginia, and within a radius of ten miles around it, there are thirty wells being pumped, averaging five barrels per day each, giving a total of one hundred and fifty barrels per day. Boring for oil in this region is constantly going on, and it is probable it will be very productive. On the Kanawha river, in Virginia, at the salt works, the oil has been "tubed out" of the wells on account of its damaging the quality of the salt, but it is believed that a large quantity could be obtained there by proper boring.

The cost of boring a well in the oil districts of Pennsylvania — from two to four inches in diameter — varies with the locality, six hundred dollars being considered sufficient for a well two hundred feet deep in some places, and two hundred dollars for one of one hundred feet in depth in others. For a well yielding ten or fifteen barrels per day, the outlay, to include tanks in which the oil is separated from water by settling, and sheds, workshops, etc., is from $1000 to $1500. The long duration of this supply of natural oil is somewhat doubtful, from the fact that a number of the wells have ceased to yield; but it is certain that an immense quantity will be obtained for years to come; and it is not improbable that, with a better knowledge of the geology of the country, and the experience which is fast accumulating, the oil wells may be made a permanent source of wealth.

Concerning the origin of these oils, no doubt can be entertained that they have exuded, or have been distilled, from animal or vegetable products, the

relics of former ages, buried in sedimentary deposits. The oils of Northern Pennsylvania come up through rocks below the coal measures, and which are older than the carboniferous limestones, which in this locality constitute the surface rocks.

At the meeting of the American Association, 1860, Professor J. D. Whitney called attention to the fact that these oils had been obtained from the Hudson river group of the Silurian rocks, in which few or no vegetable remains occur, thus leading to the inference that the oils may be entirely of animal origin.

Mr. W. Denton, a geologist of Painesville, Ohio, from a careful investigation of the subject, also comes to the conclusion that these oils have in many instances an animal origin, and that they have especially been derived from the substance of the coral animals of the Devonian and Silurian epoch. He says, in a note to the editor:—

"I have large specimens of fossil coral, the cells of which are filled with pure Seneca or Rock oil, some of them obtained more than a hundred miles from a coal region. I have seen hundreds of corals full of this oil, and these corals in the centre of limestone blocks, bearing no trace of oil anywhere except in the cells of the coral. I have seen the coral reef through which a creek has run, thus exposing it to the air, and from this reef the oil was flowing; oil having that distinctive smell which once smelled is never forgotten. It is my opinion, therefore, that the oil comes from coral reefs, lying probably in some cases two or three thousand feet below the surface. The coral cells having been crushed by the pressure of the superincumbent rocks, the oil has been forced out and collected in various crevices and reservoirs in the strata."

INTERESTING PALÆONTOLOGICAL DISCOVERIES IN NEW ENGLAND.

At the meeting of the American Association for 1860, Professor W. B. Rogers gave an account of the recent discovery, by Mr. Norman Easton, of fossils in the conglomerate of Taunton River, Massachusetts. Mr. Easton had also found fossils in the pebbles forming part of the conglomerate boulders about Fall River. In company with Mr. Easton, he had traced this conglomerate to its beds in Dighton, where they had found fossils in the pebbles *in situ*. Similar fossils had also been found in the conglomerate about Newport, R. I., and they seem to be allied to the *Lingula prima* of the Potsdam sandstone. This was opening a new field of fossils.

Colonel Foster said that he had little doubt that this was the Lingula of the Potsdam sandstone. He had no doubt that the Potsdam sandstone existed in New England, covered, perhaps, by the waters of the ocean. The geological survey of New England was yet to be made. He believed that the palæozoic rocks would be found on the Atlantic slope in full series.

Professor Rogers thought they would be found sporadically in many portions of New England; but so enormous had been the extent of the denudation that he feared that in no place could the continuous series be found.

Professor Agassiz thought the specimens were sufficient for a comparison with the fossils of the Potsdam sandstone. The discovery of the *Paradoxides* corrected one general statement, that the conglomerates of New England were of the Carboniferous period. This was another step in the same direction, and a very interesting one.

Professor Rogers spoke of the singularity of the fact that the *Paradoxides* was found also in the oldest rocks of Bohemia, separated from its fellows in New England by such wide extent of sea and land.

Professor Rogers then gave some account of his geological observations in the northeastern part of Maine. He believed that there would be found in this section rocks of the Upper Silurian, corresponding to the Clinton group, and rising into the Devonian and Lower Carboniferous towards the coal measures of New Brunswick.

Mr. J. S. Newberry then spoke of the origin and distribution of the sediments composing the stratified rocks of North America. He believed that mechanical deposition by the ocean took place only along shore, and that in the deep sea the sediments were entirely organic. He had found this to be proved by the deep-sea lead. It had been supposed that every great river carried its sediment far out to sea, but the soundings off the mouth of the Mississippi showed that the deposits were confined to a very limited space. Apparently all the sediment which was not deposited within a few miles of the mouth of the river was taken into chemical solution. He adduced many instances of rocks, from New England to New Mexico, going to prove this theory of mechanical deposition. He thought he found in the cretaceous formation of the West indications that it was deposited during a period of depression, and he believed that the tertiary of that portion of the country was deposited during a period of elevation.

REMARKABLE MASS OF METEORIC IRON.

Among the collections made by Dr. John Evans, United States Geologist for Washington Territory, is a small mass of iron, which has been examined by Dr. Charles T. Jackson, of Boston, and found to be meteoric. According to Dr. Evans, the specimen was taken from a large mass which projects three or four feet from the soil of Rogue River Mountain, in Oregon. The part exposed is four or five feet in width and length.

The following is the result of an analysis by Dr. Jackson, of Boston:—

"Specific gravity of the pure metallic mass, 7.8334; 10.7 grains yielded,—

Iron,	89.000
Nickel,	10.290
Tin and a little Silica,	0.729
	100.019

"Nitric acid produces on a polished surface the usual Widmanstatian figures." "It resembles the Siberian Pallas meteorite, and like it contains large crystals of chrysolite, the cavities left by them being as large as filberts."

This remarkable meteorite is only forty miles from Port Orford, and could be got for shipment without great expense. Dr. Jackson has urged its removal to the Smithsonian Institution at Washington.—*Mining Journal.*

NATIVE IRON IN AFRICA.

At a recent meeting of the Boston Society of Natural History, Dr. Hayes stated that he had received additional information from Liberia, Africa, which rendered it improbable that there are any deposits of native iron in that country, as has been hitherto supposed; the singular specimens of

African iron forwarded to this country, which have given rise to the supposition, owing their apparently natural structure to a peculiar method of smelting the ore adopted by the natives.

EARTHQUAKE PHENOMENA.

The following is an abstract of a lecture on the above subject recently delivered before the Royal Institution, London, by Professor Ansted: —

The whole number of recorded earthquakes upon which any dependence can be placed amounts, at present, to somewhere near 7000. (This calculation is made only up to 1850, and there have been many since). Of these 7000 we know actually the dates of a large proportion, that is, the time of year when they took place. The whole number recorded up to the year 1500 is 787 only. During the three following centuries, that is, from the beginning of the sixteenth to the end of the eighteenth, there were 2804, — four times as many as in all previous time. The whole number recorded since 1800 down to 1850 is 3340. We may conclude that 3240 in half a century is the nearest approximation as to numbers that we can at present obtain. From this, then, we may calculate our average, and we find that certainly more than one earthquake takes place every week on some or other of the visited parts of the earth. Of these, however, not more than one in every forty on an average are of great importance. An important earthquake occurs, therefore, once in every eight months; and we understand by this a disturbance of considerable magnitude, capable of doing much mischief if it occurs near human habitations. Such, at any rate, has been the average of the first half of the present century, even without making allowance for those numerous cases which must have happened, although we have heard nothing about them.

If, however, we take the statistics as far as Europe only is concerned, we shall find that during the last ten years, or rather during a period of ten years in which calculation was made very carefully (from 1833 to 1842 inclusive), thirty-three earthquakes occurred on an average in every year. In other words, in these ten years there were 320 distinct earthquakes in Europe only; and, therefore, in Europe an earthquake occurs every twelve days. It is evident that the records for other parts of the world will be much less perfect than those of Europe, and that the number generally may be far greater than is above stated. This result is startling, and I confess I was not prepared for it when the evidence came before me.

Earthquakes must be regarded as the undulations produced by the exercise of some great expansive forces acting beneath the earth's surface on tolerably well-defined zones, whenever such expansive force rapidly breaks asunder, instead of quietly and slowly heaving up the vast weight of overlying earth and sea that intervenes between its point of action and the upper surface. The convulsive or paroxysmal movement thus occasioned by the fracture of rocks at a great depth generally causes an earth-wave to be propagated to a distance which is proportioned to the amount of force exercised and the depth at which it acts, and not unfrequently opens out a communication to the surface, and terminates in a volcanic eruption. After one great wave is thus formed and sent on, it is often repeated before it quite dies away. In any case, the result at the surface consists of the propagation of a wave through rocks of various degrees of elasticity. The cracking of the earth at the surface may have nothing whatever to do with the fracture below; and

the vent, if any, may be at a great distance from the immediate source of disturbance.

Judging from their great frequency, from their constant recurrence in certain districts, and from the comparative periodicity of extreme paroxysms, as well as of minor convulsions, there would seem little doubt that some widely-spread general cause, cosmical, and not merely terrestrial, is connected with and governs the forces brought into play on these occasions. From what we know of the electric force and its relations with earth-magnetism, of the approximately superficial character of earth-magnetism, and of the certainly small depth of most earthquake movements, as proved by the small area they affect, we can hardly avoid the conclusion that to the agency of heat, initiated by electricity, and connected with those chemical results produced by the mutual action of natural substances under certain conditions of contact, we are indebted for the paroxysmal movements which record at the surface, however obscurely, what is going on far away out of our sight in nature's great laboratory.

Under the influence of the attraction of the moon and sun, the portions of the interior of the earth in a fluid state, no less than the waters of the ocean and the gases of the atmosphere, are doubtless subject to tidal influences; whilst the direct but periodic action of the rays proceeding from the sun, changing, as it appears they do, during long but definite cycles, and according to laws which we seem now only beginning to recognize, may, and most probably does, bring about periodic paroxysmal action within the earth, which may thus seem to depend on months or seasons, on the moon's position, or the sun's clearness or obscurity, or on the magnetic state of the higher parts of the atmosphere, — causes which one would think quite unlikely to have influence on what goes on so far out of the immediate range of their action. It is true that nothing has yet proved a direct connection between earthquakes and such cosmical phenomena; but what is now known supports the conclusion, that changes in terrestrial temperature, and in the circulation of electric, thermic, or magnetic currents, converting heat into force, may produce, or in some way govern, the chemical changes which result in an earthquake.

No doubt both sun and moon do, either directly or indirectly, by light, by heat, and by electricity, as well as by the force of gravitation, largely influence all that is above, upon, or beneath the surface of our planet. Perhaps also it will be found some day that the nature, and even the extent, of this influence are within the range of human discovery. These are, however, yet among the dark and unexplained mysteries of nature. We may suggest mutual relations, but we cannot follow out these suggestions into practical and definite conclusions.

And, lastly, what is our own position with reference to the chances of earthquake disturbance? We live in an area certainly subject to such movements, and not very far from those countries where the most severe earthquakes on record have happened. Earthquakes have frightened our forefathers, and may overwhelm us. The fatal explosion may happen this or next year; it may not happen in this century. It may originate beneath our very feet, or at the bottom of the ocean near our shores; or it may take place so far away that we hear only the faint, distant echoes of the convulsive throe; but we are not the less certainly living over a mine ready to be sprung, and no one can tell when or where the fatal match will be applied.

EXPLORATION OF THE VOLCANO OF PICHINCHA.

The following letter, descriptive of an exploration of the celebrated volcano Pichincha, by M. Moreno, has been published in the *Edinburgh New Philosophical Journal*: —

The short distance at which the volcano Rucu-Pichincha is situated from Quito, has contributed to excite the curiosity of the scientific travellers who have visited the territory of the Ecuador, and have caused the state and form of the volcano to be well known. Bouguer and La Condamine, in 1742, were the first who reached the brink of the crater; Humboldt, in May, 1802, twice surmounted the gigantic wall of dolerite which forms the eastern border of the volcano; and about thirty years after, Colonel Hall and M. Boussingault followed in the same path; but since 1844, in which M. Sebastin Wisse and I descended to explore it, no one had reached the bottom. In August, 1845, we returned with the intention of making the topographical plan of the volcano, measuring heights, etc.; and, in order that we might do this, we had to pass three days and three nights in the two deepest cavities which form Pichincha.

This volcano forms two great basins, one on the east of the other, 4921 English feet in length. The eastern basin, called, without sufficient reason, "Eastern Crater," has the form of a narrow valley, long and deep, through the middle of which passes, from north to south, a fissure which receives the rain and melted snow. There exists a slight depression in the upper part of this basin, of an elliptical form, and perfectly horizontal at the bottom, similar in everything to a little Alpine lake dried up by the action of the sun; a depression which at one time, from its form, gave rise to the belief in the existence of an inactive crater. The depth of this supposed crater is 1050 feet below the wall of eastern rocks; and as the highest of these reaches to 15,748 feet above the level of the sea, the height of the bottom of the eastern crater is 14,698 feet.

The western basin, or, more properly, the true crater of Pichincha, is one of the most imposing objects which is presented to naturalists, and presents the figure of a truncated cone placed upon its inferior base, which is 1476 feet in diameter, and rises in height to 2296 feet. Its depth from the eastern side is enormous; and gazing upon the immense towers of dolerite and trachyte, elevated 2460 feet, sometimes vertically, sometimes in slopes more or less steep and varied, an impression is received which can never be effaced. Towards the western part, the height of the walls of the crater diminishes gradually, leaving open to the east a fissure from whence the united waters escape during the rains or thaws.

In the middle of the inclined plain, which constitutes the bottom of the volcano, the actual cone of eruption rises; it is 820 feet in diameter, 262 in height above the bottom of the middle of the crater, and 13,707 above the level of the sea, standing 4166 feet above Quito. This little mountain is now the centre of volcanic activity in Pichincha, and presented in 1845 clear indications of remaining permanent many years without increase of intensity. A great part of this mountain is covered with vegetation; two regions, parting in opposite directions, completely gird it, until they are united in the cleft of which I have spoken; and in the two points from whence the cone of eruption is depressed (one to the centre, the other to the southeast), there is given out in abundance a hot and sulphurous vapor, which lines with sul-

phur the holes and interstices between the fragments of rock of which the cone is composed.

We failed, in the expedition of 1845, to study the volcanic and vegetable products which the crater presented. In order to examine its actual state, and to fill this blank, I descended on the 16th of December, 1857, carrying, as far as possible, what was necessary for the perilous situations in which I expected to be placed. I was engaged little more than three hours in the descent, and half-past eleven of the day found me at the cone of eruption. The form which this presents proves that the bottom of Pichincha has been recently the theatre of considerable convulsions. The vegetation which covered it has disappeared from the eastern side; the depression which exists towards the southeast, at the foot of the cone, has widened itself, and has filled up a part of the broken enclosure, interrupting it perpendicularly with a broad wall of stones, undoubtedly shot out from its interior. Near to this, and towards the south, it has formed, since 1845, a new depression, or, speaking more properly, a new accidental crater, from whence arises a great mass of vapor, so that the cone of eruption has at present three apertures or craters: the principal occupying the higher part; the ancient accidental crater placed at the southeast and at the foot of the former; and the new accidental crater open likewise at the foot and at the south of the principal one.

The volcanic activity of Pichincha has increased remarkably, as is manifested by the greater exhalation of vapors. In 1845, the chimneys from whence the gases arose formed six groups, of which only one was considerable. Now the vapors escape by innumerable interstices and hollows which the stones leave in each of the craters; and in the principal one is heard a noise resembling that made by an immense caldron of boiling water.

The temperature of the vapors varies much in the different interstices. In the crater of the southeast, the vapors of the highest interstices are nearly 188.6° Fahrenheit, whilst in the lower ones the temperature was only 140° Fahrenheit. In the principal crater, the hottest vapors did not come up to 194° Fahrenheit; in the largest interstice that I have observed, into which a person could easily enter, if the thick column of vapor would permit him, the temperature was only 98.6° Fahrenheit at three feet of depth. Filling a graduated tube with water, and placing it within the interstices, I collected the gases several times in order to analyze them, and, moreover, condensed them, by means of a bottle filled with cold water, and gathered the drops of fluid which were formed. The result of my observations is, that the gases of Pichincha contain a scarcely perceptible trace of sulphurous, sulphuric, and sulphydric acids, four per cent of carbonic acid, and the rest composed exclusively of water. I present these results only as approximate ones. The atmospheric air is always mixed with the volcanic gases in those points where it is possible to collect it; and this cause of error is inevitable, without reckoning those which occur from the personal difficulties of the observer.

The solid products of the volcano are the sublimed sulphur which covers almost all the stones and fissures, and a white salt which appears in silky fibres, and shows itself in many of the interstices, sometimes alternating with the flour of sulphur in parallel coatings, sometimes in an abundant and pure mass. This salt is a double sulphate of alum and of the protoxide of iron, likewise formed in other volcanoes, and known by the name of "*alumbre de pluma*," or plumose alum. Dissolved in water, it crystallizes by spontaneous evaporation in a derivative form of the oblique rhomboidal

prism. Besides these products, there is found scoria, composed of melted sulphur and ashes of pyroxène and dolerite, more or less calcined or altered by the action of the watery vapors.

ON THE MODE OF FORMATION OF VOLCANIC CONES AND CRATERS.

In a paper presented to the Geological Society (London) by Mr. G. Poulett Scrope, the author combated the doctrine originated by Humboldt, Von Buch, de Beaumont, and others, which denies altogether that volcanic mountains have been formed by accumulations of eruptive matters, and attributes them solely to a sudden "bubble-shaped swelling up" of preëxisting horizontal strata, the bubble sometimes bursting at the top and then leaving its broken sides tilted up around a hollow (elevation crater). The author expressed his belief that this notion originated in Humboldt's account of the eruption of Jorullo, in 1759, in which a great error had been committed,— the convexity of the hill being simply a bulky bed of lava poured out on a flat plain from five ordinary cones of eruption. But the idea of a "bladder-like swelling up" of horizontal strata into volcanic hills being thus started by Humboldt, it was further extended by Von Buch, and hence arose the "crater-elevation" theory. Mr. Scrope then proceeds to show that the characters of all volcanic mountains and rocks are simply and naturally to be accounted for by their eruptive origin, the lavas and fragmentary matters accumulating round the vent in forms determined in great degree by the more or less imperfect fluidity of the former, which, as in case of some trachytic lavas, glassy or spongy, may and do congeal in domes or bulky masses immediately over, or in thick beds near the vent, or, as in that of some basaltic lavas, may flow over very moderate declivities to great distances; and consequently that the upheaval or elevation-crater theory is a gratuitous assumption, unsupported by direct observation, and contrary to the evidence of facts. He concludes by representing its continued acceptance to be discreditable to science, and an impediment to the progress of sound geology, inasmuch as false ideas of the bubble-like inflation, at one stroke, of such mountains as Etna or Chimborazo, must seriously affect all our speculations on geological dynamics, and on the nature of the subterranean forces by which other mountain-ranges or continents are formed.

Conical Form of Volcanoes.—Sir Charles Lyell, in a paper recently read before the Royal Institution (London), infers, from two recent excursions to Etna, that the discovery of lava being capable of forming continuous and tabular masses of crystalline rock on steep slopes, often exceeding thirty degrees, enables us henceforth to dispense with that paroxysmal and terminal upheaval, which the advocates of "craters of elevation" legitimately deduced from their premises; for it was as necessary for them, so long as the volcanic beds were assumed to have been originally horizontal, to ascribe the whole elevation to a force acting from below, as it would have been if the uppermost layers of each volcanic mountain could be assumed to be of marine origin. In opposition to such a doctrine, Sir C. Lyell maintains that mechanical force has nowhere played such a dominant part in the cone-making process as to warrant our applying any other term save that of "cones of eruption" to volcanic mountains in general.

In conclusion, the lecturer gave a brief sketch of the series of geological events which he supposed to have occurred on the site of Etna since the time of the earliest eruptions,—events which may have required thousands

of centuries for their development. The first eruptions are believed to have been submarine, occurring probably in a bay of the sea, which was gradually converted into land by the outpouring of lava and scoriæ, as well as by a slow and simultaneous upheaval of the whole territory. The basalts, and other igneous products of the Cyclopean Islands, were formed contemporaneously in the same sea, the molluscous fauna of which approached very near to that now inhabiting the Mediterranean; so much so, that about nineteen-twentieths of the fossil species of the sub-Etnean tertiary strata still live in the adjoining seas. Hence, as that part of Etna which is of sub-aerial origin is newer than such fossils, the age of the mountain is proved to be, geologically speaking, extremely modern. During the period when the volcano was slowly built up, a movement of upheaval was gradually converting tracts of the neighboring bed of the sea into land, and causing the oldest volcanic and associated sedimentary strata to rise, until they reached eventually a height of twelve hundred feet, and perhaps more, above the sea-level. At the same time the old coast-line, together with the alluvial deposits of rivers, was upraised, and inland cliffs and terraces formed at successive heights. The remains of elephants, and other quadrupeds, some of extinct species, are found in these old and upraised alluviums. Fossil leaves of terrestrial plants also, such as the laurel, myrtle, and pistachio, of species indigenous to Sicily, have been detected in the oldest sub-aerial tuffs. At first the cone of Trifoglietto, and probably the lower part of the cone of Mongibello, was built up; still later the cone last mentioned, becoming the sole centre of activity, overwhelmed the eastern cone, and finally underwent in itself various transformations, including the truncation of its summit, and the truncation of the Val del Bove on its eastern flank. Lastly, the phase of lateral eruptions began, which still continues in full vigor.

IMPRESSIONS OF BONES IN THE MESOZOIC RED SANDSTONE.

At a recent meeting of the Boston Society of Natural History, Professor Rogers exhibited a cast taken from the surface of a block of red sandstone, containing the impressions of bones, apparently of ornithic character. The rock was found near the landing at Fort Adams, Newport, along with many others brought there for building purposes. It is stated to have come originally from the quarry at Portland, Conn., and evidently belongs to the Mesozoic sandstone formation of the Connecticut valley. The specimen is unique, and it is hoped that when duly examined it will help us to a more definite knowledge of some of the animals whose footprints are so abundant in this group of rocks.

ON THE FOSSIL BIRD BONES OF NEW ZEALAND.

Dr. Hochstetter, the geologist of the late Austrian Exploring Expedition, was so fortunate as to obtain in New Zealand several of the most complete collections of the bones of the extinct fossil bird (the Moa) of these islands which have yet been found, together with a perfect skull of the Moa. These were mainly exhumed from caves, and the operations of the party investigating are thus described by Dr. H.:—

The excitement of the Moa-diggers was great, and increased; for the deeper they went below the stalagmite crusts covering the floor, the larger were the bones they found, and whole legs, from the hip-bone to the claws

of the toes, were exposed. They dug and washed three days and three nights, and on the fourth day they returned in triumph to Collingwood, followed by two pack-bullocks loaded with Moa bones. I must confess that not only was it a cause of great excitement to the people of Collingwood, but also to myself, as the gigantic bones were laid before our view. A Maori bringing me two living kiwis from Rocky River gave us an opportunity to compare the remains of the extinct species of the family with the living Apteryx. The observations of M. Haast, made during this search, throw a new light upon this great family of extinct birds. He found that according to the depth so was the size of the remains, thus proving that the greater the antiquity the larger the species. The bones of *Dinornis grassus* and *ingens* (a bird standing the height of nine feet) were always found at a lower level than the bones of *Dinornis didiformis* (Owen) of only four feet high. These gigantic birds belong to an era prior to the human race, to a post-tertiary period. And it is a remarkable, incomprehensible fact of the creation, that whilst at the very same period in the Old World elephants, rhinoceroses, hippopotami; in South America, gigantic sloths and armadillos; in Australia, gigantic kangaroos, wombats, and dasyures were living; the colossal forms of animal life were represented in New Zealand by gigantic birds, who walked the shores then untrod by the foot of any quadruped.

PRESERVATION OF FOOTPRINTS ON THE SEA-SHORE.

Mr. Alexander Bryson, in a paper communicated to the Royal Society, remarks that the impressions of the feet of birds and molluscs on wet sand were liable to be effaced by the return of the tide; and that their preservation was owing to dry sand blown into the depressions from the shore, and again covered by a layer of moist sand or mud by the return of the tide. In regard to tracks left by gasterapodous molluscs, he stated that great caution was necessary to distinguish them from those left by Nereids; and instanced the case of a foot-track of a common whelk resembling the marks made by the Crossopodia on the Silurian slates. When the track of the whelk is filled up by the dry sand blown into the depression in the *line* of progress, no difficulty is felt in recognizing it as the track of a gasteropod; but should the wind blow at right angles to the track of a mollusc, a series of setæ-like markings will be observed to leeward, caused by the dry sand adhering to the moist. In this instance, a geologist would naturally assign the markings to the impression of *Graptolites priodon*, or *sagittatus;* and if the wind suddenly shifted to the opposite direction, another series of setæ would be found on the other side of the mollusc's track, and the observer would at once pronounce the marks due to a gigantic Crossopodia, or fringe-footed Annelide.

The author also stated that the so-called rain-marks found on sandstone and Silurian slates were formed by crustacea, and that the cusps, which geologists had supposed were the evidence of the force and direction of the wind during the shower, were produced by the wind blowing dry sand from the shore, and causing a raised barrier to leeward of the depression, where there was more moisture, and consequently more adhesion to the sand.— *Edinburgh New Philos. Journal.*

ON THE EXTINCT MARSUPIAL ANIMALS OF AUSTRALIA.

The following is an abstract of a lecture recently delivered by Professor Owen, at the Government School of Mines, London, on the extinct quadrupeds whose remains have been recently discovered in the caverns of Australia, and in the auriferous and other tertiary deposits of that country.

All the species which he had reconstructed from those fossils belonged to the same low group of mammalia, with small brains, to which the living marsupial quadrupeds belong. Not any marsupial species is indigenous to the continents of Europe, Asia, or Africa. On the discovery of America, some small quadrupeds of that continent became known to naturalists, as being peculiar by possessing a pouch in which the young were protected and carried for some time after birth, whence the name *Marsupialia*, signifying "pouched beasts." The American species all belong to one genus, called *Didelphys*, or opossum. They are small insectivorous quadrupeds, and most of them dwell in trees.

When Captain Cook and Sir Joseph Banks returned from the circumnavigatory voyage in which Botany Bay was discovered, they brought information of other marsupial animals which lived in Australia, and especially that called the "kangaroo," so remarkable for the length and strength of the hind legs and tail. The subsequent travellers and settlers in Australia soon transmitted additional information, with specimens of the peculiar marsupial quadrupeds of that continent, so that the *Marsupialia* are now known as an extensive order, the species of which are restricted to America, Australia, Tasmania, New Guinea, and a few islands extending thence towards Asia.

The principal genera were then described, some being carnivorous, others insectivorous, others frugivorous, or feeding on buds and leaves, others herbivorous, others burrowing and living on roots. The opossums (*Didelphys*) are peculiar to America; none are found in Australasia. The greatest number and diversity of marsupial quadrupeds exist in Australia and Tasmania.

Of the present known existing *Marsupialia*, the largest species are the great kangaroo (*Macropus major*), familiar to most by living specimens in menageries and zoological gardens, and the *Thylacine*, or hyena of the Tasmanian colonist; the latter is carnivorous, and about the size of the shepherd's dog. Most of the *Marsupialia* are smaller than the common cat.

Professor Owen then proceeded to give a history of the discovery of fossil remains of animals in Australia. The first which he noticed was that made by Major, afterwards Sir Thomas, Mitchell, the Surveyor General of Australia in 1831. In his first exploring expedition, this traveller discovered extensive caves in a limestone district of Wellington Valley, and in the breccias of the caves he found many fossil bones and teeth, which were submitted to Professor Owen's inspection, and described by him in the appendix to the account of the expedition published by Sir T. Mitchell in 1838. Among these cave fossils Professor Owen had discovered remains of the phalanger (*Phalangista*), the wombat (*Phascolomys*), the potoroo (*Hypriprymnus*), the kangaroo (*Macropus*), the *Dasyurus* and *Thylacinus*. But, although the fossils were referable to the foregoing existing genera, they were all different from any species now known. Among the kangaroos were two species which were much larger than the *Macropus major:* the remains of the *Dasyurus* were larger than those of the *D. ursinus*, which is now the largest living species, and is peculiar to Tasmania. The *Thylacinus*,

also, was by this discovery known to have formerly lived in Australia, as well as in Tasmania, to which it is now restricted. But, besides the foregoing fossils, there was a single tooth, an incisor or tusk of some quadruped which must have equalled a large ox or a rhinoceros in size. In this tooth Professor Owen perceived such characters as led him to found upon it a new genus, which he termed *Diprotodon*.

In 1844 Professor Owen received some fossils from Dr. Hobson, of Melbourne, which had been discovered in sinking a well at Mount Macedon, near Port Philip. These fossils included a portion of the lower jaw, having an incisive tusk *in situ*, identical in shape and structure with that on which the genus *Diprotodon* had been founded, and also molar teeth, resembling in form those of the kangaroo, but with generic modifications. This confirmation of the former existence in Australia of a gigantic marsupial herbivorous quadruped allied to the kangaroo was communicated to the British Association at their meeting in 1844, and was noticed in the *Annals* and *Magazine of Natural History* for October, 1844. In the same paper Professor Owen stated that he had received from Sir Thomas Mitchell some Australian fossils, indicative of a second genus of large marsupial quadrupeds, which he described under the name *Nototherium*.

Although the molar teeth in both the *Diprotodon* and *Nototherium* presented the same two-ridged type as in the kangaroo, they differed in wanting the smaller connecting ridge; and Professor Owen was led to infer, from the structure of the *astragalus* and *calcaneum* (two of the ankle bones), that the hind limbs differed in a greater degree from those of the present kangaroos. The above-named tarsal bones had been transmitted, with other fossil bones, from Moreton Bay, by Sir Thomas Mitchell; they presented marsupial characters, and by their size might have belonged to either the *Diprotodon* or *Nototherium*. In the kangaroos these ankle bones have peculiarities associated with the very long hind legs; but the large fossil ones resemble more those of the wombat; whence Professor Owen inferred that the *Diprotodon* must have had the hind limbs more nearly equal in length to the fore limbs. Subsequent discoveries proved the truth of this inference.

In 1847, a Mr. Turner brought from Darling Downs to Sydney, New South Wales, a large collection of fossil bones, chiefly obtained from King's Creek, a tributary of the Condamine River, Darling Downs. These downs are extensive, slightly undulated plains covered with herbage, developed from a rich, black soil containing concretions of carbonate of lime. Ranges of low hills, with sudden slopes, and flat-topped cones formed of basaltic rock, resting on a felspathic or trachytic base, accompany the shallow valleys, and bear an open forest, formed of various species of rather stunted *Eucalyptus*. The plains are filled with an alluvium of great depth, wells of sixty feet deep having been sunk in it. The plains in which the fossils have been found are those distinguished by the creeks called Hodgson's, Campbell's, Isaac's, King's, Oakey's, etc. These creeks traverse the plains on the west side of the Condamine, into which they fall. The fossils are found in the beds of the creeks, particularly in the mud of the dried-up waterholes, or among beds of trachytic pebbles, which are overlaid by layers of clay and loam, with marly concretions, above which is the rich, black surface soil.

Fossil bivalve and univalve shells are found associated with, and sometimes cemented to, the bones; but they are of the same species as those still existing in the present creeks and waterholes.

The most extraordinary of the fossils brought from King's Creek by Mr.

Turner was an almost entire skull of the *Diprotodon Australis*. The length was three feet; the two great anterior tusks, whence the name "Diprotodon," projected a few inches beyond that length. Behind these tusks were two smaller incisors in each premaxillary bone; but these six upper incisors were opposed, as in the kangaroo, by a single pair of large incisors in the lower jaw.

The characters of this extraordinary cranium were described by Professor Owen, and illustrated by drawings of the natural size. A descending process of the zygomatic arch was pointed out as illustrating the affinities of the *Diprotodon* with the *Mycropus* or the kangaroos.

With this skull had been found a large bladebone two feet four inches long, a humerus two feet two inches in length, a femur two feet five inches in length, remarkable for the great extent of the neck; several vertebræ, fragments of ribs, and other bones, all agreeing in proportion with the skull, and belonging to the same species, and most probably to the same individual.

This collection of bones, when brought to Sydney, was noticed by the Rev. Mr. Clarke and by Mr. Macleay in letters in the Sydney *Morning Herald*, and plaster casts were taken of the chief specimens. The whole collection was purchased of Mr. Turner by a Mr. Boyd, who was about to return to England. This gentleman is stated to have died on the voyage, and the ship in which the fossils had been embarked was said to have been wrecked, and its whole cargo was supposed to have been engulfed. A series of the casts of the fossils taken at Sydney were transmitted by the authorities of the museum there to the trustees of the British Museum. About the time when these casts arrived, a sale of fossil remains took place at Stevens's auction-rooms; these fossils were found to belong to large marsupial animals, were purchased for the British Museum, and proved to be originals from which the casts in the Sydney Museum had been taken. The auctioneer stated that they had been the property of a Mr. Boyd. They will form the subject of a memoir by Professor Owen. Besides the parts of the skeleton of the great *Diprotodon*, they included a lower jaw of the same large extinct marsupial which the professor had previously determined under the name of *Nototherium Mitchelli;* and this jaw showed that there were two incisive tusks and ten molar teeth, five on each side, in that genus.

In January, 1858, Professor Owen received from Mr. George Bennett, F.R.S., of Sydney, sketches of a fossil cranium, which had been found in the same formation and locality in Darling Downs as the *Diprotodon*. This new skull was eighteen inches long and fifteen inches wide. It had three incisors and five molars on each side, and, from its correspondence in size with the lower jaw of the *Nototherium*, the Professor believed it to belong to that genus. A cast of the cranium had been sent from Sydney to the British Museum, and has served to show that a fragment of upper jaw with molar teeth, in Mr. Turner's collection, belonged to the same genus. These teeth show precisely that structure which Professor Owen had previously pointed out as distinguishing the teeth of the *Nototherium* from those of the *Diprotodon*. The lower jaw of the *Nototherium Mitchelli* in Mr. Turner's series, now in the British Museum, belongs to the same species as the cranium now in the museum at Sydney. This cranium is chiefly remarkable for the great size and width of the zygomatic arches, which have also the descending process as in the *Diprotodon*. The facial bones in advance of the orbit form a kind of short pedunculate appendage to the rest of the skull, increasing in

a remarkable manner in both vertical and lateral extents towards its fore extremity. The cavity of the nose was divided by a bony septum, as in one species of the wombat. Thus were established proofs of the former existence in Australia of two genera of herbivorous marsupial animals, resembling the *pachyderms* in proportions; one (*Diprotodon*) equalling or surpassing in size the largest living rhinoceros, the other (*Nototherium*) equalling the ox or tapir.

Prof. Owen next referred to some fossils in the collection sent by Dr. Hobson, from Melbourne, Australia Felix, which belonged to a species of true wombat (*Phascolomys*), but four or five times larger than the largest known existing species. These species had been noticed by the professor, and referred to *Phascolomys gigas*, in the *Transactions of the Zoölogical Society*. As early as 1842, Professor Owen inferred from the fact of there having been large herbivorous animals in Australia in former periods that a large carnivorous animal had coëxisted with them. In a letter to the editor of the *Annals of Natural History*, November 1, 1842, he writes: "Some destructive species of this kind must have coëxisted of larger dimensions than the extinct *Dasyurus Laniarius*, the ancient destroyer of the now equally extinct gigantic kangaroo (*Macropus Titan*), whose remains were discovered in the bone caves of Wellington Valley." The Rev. Mr. Clarke, in his report to the Governor of Australia, No. 10, October 14, 1853, "On the Geology of the Basin of the Condamine River," referring to this remark, observes: "The discovery of what *must have existed* cannot be altogether incapable of demonstration; and, therefore, such a verification of Professor Owen's anticipation is to be hoped for on many grounds."

In 1846, the professor received from Mr. William Adeney portions of a fossil skull of a carnivorous quadruped as large as a lion. These fossils were discovered in the banks of the Timboon Lake, situated eighty miles southwest of Melbourne. The lake is shallow, and becomes almost dry in autumn, when its bed is covered with a pretty thick deposit of common salt of good quality. The surrounding country is volcanic. The fossils occur in a narrow white strip of calcareous conglomerate, traversing the clay cliff, which is here and there indented with capes of basaltic boulders. The fossil in question included part of the right maxillary bone, with the last two molar teeth. The first of these presented the trenchant or carnassial type of crown; the second was a small tubercular tooth, situated, as in the lion and tiger, on the inner side of the back part of the carnassial. The crown of the carnassial was two and a quarter inches in extent, that of the largest lion being one and a half inches; the margin of this flesh-cutting tooth is straight in the fossil, not indented as in the lion. A portion of the right ramus of the lower jaw contained two teeth answering to those above, the carnassial with an even cutting edge of one and a half inches in length; the tubercular, which is directly behind, is only half an inch long, and it is followed by the socket of a still smaller molar. On closely comparing this fossil with the skulls of existing carnivorous animals of the placental and marsupial orders, Professor Owen concluded from the structure of the occiput, of the organ of hearing, of the bony palate, and of the orbit in reference to the position of the lachrymal hole, that the large carnivore represented by that fossil belonged to the marsupial order, not to the placental carnivora. He had proposed for it the name *Thylacoleo*, or "lion with a pouch."

Thus were completed, by evidence of species of quadrupeds that appear to have become extinct in Australia, the representatives in the marsupial series

of the chief forms of the terrestrial mammalia known in other parts of the globe.

The professor, in conclusion, referred to the character, as one natural continent, of the vast tract of dry land now artificially divided into Europe and Asia; and he showed that all the fossil remains of quadrupeds from caves and recent tertiary strata in Europe, coeval with the ossiferous caves and strata in Australia, belonged to genera which still had existing representatives in Europe or Asia, such, *e. g.*, as the horse, the elephant, the rhinoceros, oxen, deer, bears, hyænas, felines, etc. The hippopotamus, indeed, had become extinct in Asia, as in Europe, but still existed in Africa. He then made a similar comparison between the aboriginal quadrupeds of South America now living, such as the sloths, armadillos, ant-eaters, platyrhine, monkeys, llamas, peccaris, and the fossil megatheroids, glyptodons, glossotheres, large fossil monkeys, *Macranchenicæ*, and peccaris. Australia had already yielded evidence of an analogous correspondence between its latest extinct and its present mammalian fauna; and this was the more interesting and striking on account of the very peculiar organization of the native quadrupeds of that division of the globe. The marsupials there represent analogously the chief land quadrupeds of the larger continents; the *Dasyures*, *e. g.*, play the parts of the foxes and marten-cats; the bandicoots (*Perameles*), of the hedgehogs and shrews; the phalangers and koolas, of the squirrels and monkeys; the wombats, of the beavers; the kangaroos, of the deer tribe.

The first collection of the mammalian fossils from the bone breccias of the Australian caves had brought to light the former existence of large species of existing marsupial *genera*, some of which, for example, the *Thylacinus* and *Sarcophilus*, though now seemingly extinct in Australia proper, are still represented by species in the adjacent island of Tasmania; the others were fossil wombats, phalangers, potoroos, and kangaroos, but of different species. The fossils of the herbivorous marsupialia were of young, or not full-grown, animals, whence the Professor inferred that they had been dragged into the cave to be devoured. Subsequently, and at short intervals, fossils had been obtained from pliocene strata, and these had demonstrated the former existence of marsupial animals representing the great *pachyderms* of Asia and the *Megatherium* of America, together with a marsupial beast of prey, rivalling the lion or tiger in size, and equal to cope with the *Diprotodon* or *Nototherium*.

Thus, it was shown that, with regard to the last extinct (pliocene) kinds, as with the existing kinds of mammalia, particular forms were assigned to particular continents or provinces; and, what was still more interesting and suggestive, the same forms were restricted to the some provinces at a former geological period as they are at the present day.

ON THE PLEISTOCENE HISTORY OF SCOTLAND.

In a communication by T. F. Jamieson, recently presented to the London Geological Society by Sir R. I. Murchison, he expresses his opinion that the following course of events may be supposed to have occurred in the Pleistocene history of Scotland: First, a period when the country stood as high as, or probably higher than, at present, with an extensive development of glaciers and land ice, which polished and striated the subjacent rocks, transported many of the erratic blocks, destroyed the preëxisting alluvium, and

left much boulder-earth in various places. Secondly, To this succeeded a period of submergence, when the sea gradually advanced until almost the whole country was covered. This was the time of the marine drift with floating ice. The beds with arctic shells belonged to it, and some of the brick-clays are probably but the fine mud of the deeper parts of the same sea-bottom. Thirdly, The land emerged from the water, during which emergence the preceding drift-beds suffered much denudation, giving rise to the extensive superficial accumulations of water-rolled gravel that now overspread much of the surface. This movement continued until the land obtained a higher position than it now has, and became connected with the continent of Europe. Its various islands were probably also more or less in conjunction. The present assemblage of animals and plants gradually migrated hither from adjoining lands. Glaciers may have still been formed in favorable places, but probably never regained the former extension. Fourthly, The land sank again until the sea in most places reached a height of from thirty to forty feet above the present tide-mark. Patches of forest ground were submerged along the coast. Fifthly, An elevation at length took place, by which the land attained its present level. As Mr. Smith has shown, this probably occurred before the Roman invasion; but that man had previously got into the country, appears from the fact that the elevated beds of silt near Glasgow contained overturned and swamped canoes with stone implements.

INTERESTING FOSSILS FROM GREECE.

During the past year M. Gaudry, a French geologist, has been engaged in exploring some deposits of reddish earth at Pakermi, in the district of Attica, Greece, which were known to be rich in the remains of extinct mammalia. These deposits have been formed by erosion of the rocks of Pentelicus; toward the summit of the mountain they are thin, but increase in thickness the nearer they approach to the plains, and they extend to the margin of the sea, covering a very large area.

Among the objects already brought to light by these explorations are seventeen skulls of monkeys, with the jaws and teeth in many instances still perfect; the head of a gigantic specimen of the swine species; four complete skeletons of the rhinoceros, the skull of a pachydermous animal larger than the rhinoceros, the jaws being remarkable for possessing sixteen large molar teeth; the head of a *Mastodon*, with the incipient germs of the molars and tusks; a skeleton, nearly perfect, of the *Dinotherium*, the most gigantic of known fossil animals, its tibia measuring a fifth more in length than that of the Ohio *Mastodon;* the principal bones of a huge fowl of the gallinaceous order; and, finally, the skeleton of two kinds of giraffes, one similar to the living species, the other less slender, together with bones of antelopes, turtles, and many other animals. Of these fossils, forty-one cases are already in the hands of geologists in Paris.

SOME GENERAL VIEWS ON ARCHÆOLOGY.—BY A. MORLOT.

The following article, derived from *Silliman's Journal*, is an introduction to a paper entitled Geologico-Archæological Studies in Denmark and Switzerland, appearing in the *Bulletin de la Société Vaudoise des Sciences Naturelles*, for 1859.

A century scarcely has elapsed since the time when it would have been thought impossible to reconstruct the history of our globe, prior to the appearance of mankind. But, though contemporary historians were wanting during this immense pre-human era, the latter has not failed in leaving us a well-arranged series of most significant vestiges: the animal and vegetable tribes, which have successively appeared and disappeared, have left their fossil remains in the successively deposited strata. Thus has been composed, gradually and slowly, a history of creation, written, as it were, by the Creator himself. It is a great book, the leaves of which are the stratified rocks, following each other in the strictest chronological order, the chapters being the mountain chains. This great book has long been closed to man. But science, constantly extending its realm and improving its method of induction, has taught the geologist to study those marvellous archives of creation, and we behold him now unfolding the past ages of our world, with a variety of details and a certainty of conclusions well calculated to inspire us with grateful admiration.

The development of archæology has been very similar to that of geology. Not long ago we should have smiled at the idea of reconstructing the bygone days of our race, previous to the first beginning of history properly so called. The void was filled up, partly by representing that ante-historical antiquity as having been only of short duration, and partly by exaggerating the value and the age of those vague and confused notions which constitute tradition.

It seems to be with mankind at large as with single individuals. The recollections of our earliest childhood have entirely faded away, up to some particular event which had struck us more forcibly, and which alone has left a striking image amidst the surrounding darkness. Thus, excepting the idea of a deluge, which exists among so many nations, and therefore appears to have originated before the migration of those same nations, the infancy of mankind, at least in Europe, has passed without leaving any recollection, and history fails here entirely: for what is history but the memory of mankind?

But, before the beginning of history, there have been life and industry, of which various monuments still exist, while others lie buried in the soil, much as we find the organic remains of former creations entombed in the strata composing the crust of the globe. The memorials of antiquity enact here a part similar to that of the fossils; and if Cuvier calls the geologist an antiquarian of a new order, we can reverse that remarkable saying, and consider the antiquarian as a geologist, applying his method to reconstruct the first ages of mankind, previous to all recollection, and to work out what may be called pre-historical history. This is archæology pure and proper. But archæology cannot be considered as coming to a full stop with the first beginning of history. For the further we recede in our historical researches, the more incomplete they become, leaving gaps which the study of the material remains helps to fill up. Archæology, therefore, pursues its course in a parallel line with that of history, and henceforth the two sciences mutually enlighten each other. But, with the progress of history, the part taken by archæology goes on decreasing, until the invention of printing almost brings to a close the researches of the antiquarian.

To pursue geological investigations we must first examine the present state of our planet and observe its changes, that is, we must begin by physical geography. This supplies us with a thread of induction, to guide us safely in our rambles through the passed ages of our earth, as Lyell has so

admirably set forth. For the laws which govern the organic creation and the inorganic world are as invariable as the results of their combinations and permutations are infinitely varied; science revealing to us everywhere the perfect stability of the causes with the diversity of the forms.

So, to understand the past ages of our species, we must first begin by examining its present state, following man wherever he has crossed the waters and set his foot upon dry land: the different nations, which inhabit our earth at present, must be studied with respect to their industry, their habits, and their general mode of life. We thus make ourselves acquainted with the different degrees of civilization, ranging from the highest summit of modern development to the most abject state, hardly surpassing that of the brute. By that means ethnography supplies us with what may be called a contemporaneous scale of development, the stages of which are more or less fixed and invariable, whilst archæology traces a scale of successive development, with one movable stage passing gradually along the whole line.

Ethnography is, consequently, to archæology what physical geography is to geology, namely, a thread of induction in the labyrinth of the past, and a starting point in those comparative researches of which the end is the knowledge of mankind and of its development through successive generations.

In following out the principles above laid down, the Scandinavian savans have succeeded in unravelling the leading features in the progress of prehistorical European civilization, and in distinguishing three principal eras, which they have called the *stone-age*, the *bronze-age*, and the *iron-age*.

The earliest settlers in Europe apparently brought with them the art of producing fire. By striking iron-pyrites (sulphuret of iron) against quartz, fire can be easily obtained. But this method can only have been occasionally used, and seems to be now confined to some native tribes in Terra del Fuego. The usual mode had evidently been that of rubbing two sticks together. But on further reflection it is easy to perceive that this was a most difficult discovery, and must at all events have been preceded by a knowledge of the use of fire, as derived from the effects of lightning or from volcanic action.

The stone-age was, therefore, probably preceded by a period, perhaps of some length, during which man was unacquainted with the art of producing fire. This, according to Mr. Flourens, indicates that the cradle of mankind was situated in a warm climate.

The art of producing fire has been perhaps the greatest achievement of human intelligence. The use of fire lies at the root of almost every species of industry. It enables the savage to fell trees, as it allows civilized nations to work metals. Its importance is so great, that deprived of it man would perhaps scarcely have risen above the condition of the brute. Even the ancients were sensible of this, as is witnessed by the fable of Prometheus. As to their sacred perpetual fire, its origin seems to lie in the difficulty of procuring fire, thereby rendering its preservation essential.

In Europe the stone-age came to an end by the introduction of bronze. This metal is an alloy of about nine parts of copper and one part of tin.[1] It

[1] Bronze is still used for casting bells, cannon, and certain portions of machinery. It must not be confounded with common brass, which is a compound of copper and zinc, much less hard, and appearing only in the iron-age.

melts and moulds well; the molten mass in cooling slowly acquires a tolerable degree of hardness, inferior to that of steel, it is true, but superior to that of very pure iron. We therefore understand how bronze would long be used for manufacturing cutting-instruments, weapons, and numerous personal ornaments. The northern antiquaries have very properly called this second great phase in the development of European civilization the *bronze-age*.

The bronze articles of this period, with a few trifling exceptions, have not been produced by hammering, but have been regularly cast, often with a considerable degree of skill. Even the sword-blades were cast, and the hammer (of stone) was only used to impart a greater degree of hardness to the edge of the weapon.

The bronze-age has therefore witnessed a mining industry, which was completely wanting during the stone-age. Now the art of mining is so essential to civilization, that without it the world would perhaps yet be exclusively inhabited by savages. It is then worth our while to inquire more closely into the origin of bronze.

Copper was not difficult to obtain. In the first place, virgin copper is not particularly scarce. Then, the different kinds of ore which contain copper combined with other elements are either highly colored, or present a marked metallic appearance, and are consequently easily known; they are besides not hard to smelt, so as to separate the metal. Finally, copper ore is not at all scarce; it is met with in the older geological series of most countries.

Virgin tin is unknown, but tin ore is heavy, of dark color, and very easy to smelt. However frequent copper may be, tin is of rare occurrence. Thus the only mines in Europe which produce tin at the present day are those of Cornwall in England, and of the Erzgebirge and Fitchtelgebirge in Germany.

But the question arises whether, previous to the discovery of bronze, man, owing to the great rarity of tin, may not have begun by using copper in a pure state. If so, there would have been a copper-age between the stone-age and the bronze-age.

In America this has been really the case. When discovered by the Spaniards, both the two centres of civilization, Mexico and Peru, had bronze, composed of copper and tin, and used it for manufacturing arms and cutting-instruments in the absence of iron and steel, which were unknown in the New World. But the admirable researches of Messrs. Squier and Davis in the antiquities of the Mississippi valley have brought to light an ancient civilization of a remarkable nature, and distinguished by the use of raw virgin copper, worked in a cold state, by hammering, without the aid of fire. The reason of its being so worked lies in the nature of pure copper, which when melted flows sluggishly and is not very fit for casting. A peculiar characteristic of the metal, that of occasionally containing crystals of virgin silver, betrays its origin, and shows that it was brought from the neighborhood of Lake Superior. This region is still rich in metallic copper, of which single blocks attaining a weight of fifty tons have lately been discovered. There was even found at the bottom of an old mine a great mass of copper which the ancients had evidently been unable to raise, and which they had abandoned, after having cut off the projecting parts with stone hatchets.

The date of that American copper-age is unknown. All we know is, that it must reach at least as far back as ten centuries, that space of time being deemed necessary for the growth of the virgin forests now flourishing upon the remains of this antique civilization, of which the modern Indians have not even retained a tradition.

It is, finally, worthy of remark, that the *mound-builders*, as the Americans call the race of the copper-age, seem to have immediately preceded and prepared the way for the Mexican civilization, destroyed by the Spaniards; for, in progressing southwards, a gradual transition is noticed from the ancient earthworks of the Mississippi valley to the more modern constructions of Mexico, as found by Cortez.

In Europe the remains of a copper-age are wanting. Here and there a solitary hatchet of pure copper is found. But this can be accounted for by the greater frequency of copper, while tin had usually to be brought from a greater distance, so that its supply was more precarious.

As Europe did not witness a regular development of a copper-age, it seems, according to Mr. Troyon's very just remark, that the art of manufacturing bronze was brought from another quarter of the world, where it had been previously invented. It was most probably some region in Asia, producing both copper and tin, where those two metals were first brought into artificial combination, and where also traces of a still earlier copper-age are still likely to be found.

An apparently serious objection might be started here by raising the question how mines could be worked without the aid of steel. This, however, is sufficiently explained by the fact, that the hardest rocks can be easily managed through the agency of fire. By lighting a large fire against a rock, the latter is rent and fissured, so as considerably to facilitate the quarrying. This method was frequently employed when wood was cheaper, and is even practised at the present day in the mines of the Rammelsberg in Germany, where it facilitates the working of a rock of extreme hardness.

That metal of dingy and sorry appearance, but more truly precious than gold or the diamond, — iron, — at length appears, giving a wonderful impulse to the progressive march of mankind, and characterizing the third great phase in the development of European civilization, very properly called the *iron-age*.

Our planet never produces iron in its metallic or virgin state, for the simple reason that it is too liable to oxidation. But among the aerolites there are some composed of pure iron with a little nickel, which alters neither the appearance nor sensibly the qualities of the metal. Thus the celebrated meteoric iron discovered by Pallas in Siberia was found by the neighboring blacksmiths to be malleable in a cold state. Meteoric iron has even been worked by tribes to whom the use of common iron was unknown. Thus Amerigo Vespucci speaks of savages near the mouth of the La Plata who had manufactured arrow-heads with iron derived from an aerolite. Such cases are certainly of rare occurrence, but they are not without their importance, for they explain how man may probably first have become acquainted with iron, and they also account for the occasional traces of iron in tombs of the stone-age, if indeed this fact be well established.

It is, notwithstanding, evident that the regular workings of terrestrial iron-ore must have been a necessary condition of the commencement and progress of the iron-age.

Now, iron-ore is widely diffused in most countries, but it has usually the look of common stones, being distinguished more by its weight than its color. Moreover, its smelting requires a much greater degree of heat than copper or tin, and this renders its production considerably more difficult than that of bronze.

But, even when iron had been obtained, what groping in the dark and

how much accumulated experience did it not require to bring forth at will bar iron or steel! Chance, if chance there be, may have played a part in it. But as chance only favors those privileged mortals who combine a keen spirit of observation with serious meditation and with practical sense, the discovery was not less difficult or meritorious. We need not then be surprised if man arrived but tardily at the manufacture of iron and steel, which is still daily improving.

In Carinthia traces of a most primitive method of producing iron have been noticed. The process seems to have been as follows: on the declivity of a hill was dug an excavation, in which was lighted a large fire; when this began to subside, fragments of very pure ore (hydrous-oxide) were thrown into it and covered by a new heap of wood. When all the fuel had been consumed, small lumps of iron would then be found among the ashes. All blowing apparatus was in this manner dispensed with; an important fact when we come to consider how much the use of a blast complicates metallurgical operations, because it implies the application of mechanics. Thus certain tribes in Southern Africa, although manufacturing iron and working it tolerably well, have not achieved the construction of our common kitchen bellows, apparently so simple; they blow laboriously through a tube, or by means of a bladder affixed to it.

The Romans produced iron by the so-called Catalonian process, and the remains of Roman works of that description have been discovered and investigated in Upper Carniola in Austria. The Catalonian forge is still used in the Pyrenees, where it yields tolerable results, but it consumes a large quantity of charcoal, requires much wind, and is only to be applied to pure ore, containing but a very small proportion of earthy matter producing scoriæ: for the process consists in a mere reduction, with a soldering and welding together of the reduced particles, without the metal properly melting. According to the manner in which the operation is conducted, bar iron or steel are obtained at will. This direct method dispenses with the intermediate production of cast iron, which was unknown to the ancients, and which is now the only means of producing iron on a great scale.

Silver accompanies the introduction of iron into Europe, at least in the northern parts, while gold was already known during the bronze-age. This is natural, for gold is generally found as a pure metal, while silver has usually to be extracted from different kinds of ore by more or less complicated metallurgical operations, — for example, by cupellation.

With iron appear also, for the first time in Europe, glass, coined money, that powerful agent of commerce, and finally the alphabet, which, as the money of intelligence, vastly increases the activity and circulation of thought, and is sufficient of itself to characterize a new and wonderful era of progress. From thence can we date the dawn of history and of science, in particular of astronomy.

The fine arts also reveal, with the introduction of iron in Europe, a new and important element, indicating a striking advance. Already in the stone-age, but more in the bronze-age, the natural taste for art reveals itself in the ornaments bestowed upon pottery and metallic objects. These ornaments consist in dots, circles, and zigzag, spiral, and S-shaped lines, the style bearing a geometrical character, but showing pure taste and real beauty of its kind, although devoid of all delineations of animated objects, either in the shape of plants or animals. It is only with the iron-age that art, taking a higher range, rose to the representation of plants, animals, and even of the

human frame. No wonder, then, if idols of the bronze-age, as well as of the stone-age, are wanting in Europe. It is to be presumed that the worship of fire, of the sun, and of the moon, was prevalent in remote antiquity, at least during the bronze-age, perhaps also during the stone-age.

The preceding remarks constitute a sketch, certainly very rough and imperfect, of the development of civilization. They establish, however, in a striking manner, the fact of a progress, slow, but interrupted and immense, when the starting-point is considered. The physical constitution of man has naturally benefited by it. The details contained in the treatise, of which the present paper forms the introduction, prove that the human race has been gradually gaining in vigor and strength since the remotest antiquity. The domestic races also, the dog first, then the horse, the ox, the sheep, have shared in this physical development. Even the vegetable soil has been gradually improving since the stone-age, at least in Denmark.

ON THE GEOLOGICAL AGE OF MAN.

Both the literary and scientific journals of Europe published during the past year abound with correspondence and articles on the vexed question, which is now engaging the attention of geologists, viz. the origin of the flint implements found in connection with the fossil remains of extinct animals in the drift, and in the so-called bone-caverns. In former volumes of the Annual of Scientific Discovery, a full and popular account has been given of all the points of interest in regard to the subject, which had (up to date) been brought before the public; and in the present article we present our readers with a *resumé* of the principal transactions, in regard to the same topic, that have been brought to our notice during the past year. — Ed.

We would first call attention to the following letter, sent to the editor of the London *Athenæum*, by Mr. J. A. Worsaac, the well-known northern antiquarian, of Copenhagen.

After alluding to the lack of general information respecting the discoveries of antiquarians in Denmark and other countries, he observes: —

At the last meeting of the British Association, Sir Charles Lyell, in his opening address to the Section of Geology, mentioned a large Indian mound at Cannon's Point on St. Simon's Islând, in Georgia, "ten acres in area, and having an average height of five feet, chiefly composed of cast-away oyster-shells, throughout which arrow-heads, stone axes, and Indian pottery are dispersed." Now, exactly similar mounds have been seen on the coast of Denmark, especially in the Kattegat and its "fiords" or bays. They have been examined by the well-known naturalists, Professors Steenstrup and Forchhammer, and by myself, as members of a committee appointed for the purpose by the Royal Academy of Copenhagen, and have been found to contain myriads of cast-away shells of various common species, mixed up with broken bones of stags, deer, of *Bos urus*, beaver, wild boar, etc., together with charcoal, ashes, burnt stones, pieces of very coarse pottery, rude hatchets, spear-heads, knives, arrow-heads, flakes or chips, chipping-blocks, etc., of flint, a sort of hatchets or hammers made of stag's horn, different implements of bone, and very simple ornaments of bone, etc. Traces of such mounds have been discovered, in the course of ten years, in at least fifty different places near the sea-coasts of Denmark, and the descriptions of most of them have been inserted in the *Proceedings* of our Royal Academy. It is quite evident that the greater part of the bones of animals found among

the shells have been broken according to a certain system, — most probably for getting out the marrow. The committee, without knowing of the Indian mound described by Sir Charles Lyell, unanimously came to the conclusion (1849–50) that the mounds in Denmark indicated the places where the aborigines used constantly to eat their meals.

The implements of bone and stone discovered in these mounds are mostly of the same forms, and of the very rudest description. The implements of flint are in general neither ground nor polished; they present, even, quite peculiar simple forms, different from the forms of the common hatchets and implements of the stone-age. At the commencement, when we only knew a few such mounds, I believed these differences of forms to be accidental, and I ascribed, accordingly, the mounds with their rude implements of flint to the same period as the common stone implements, and the large tombs, stone-chambers, or cromlechs of the stone-age.

But two years ago, in comparing the many flints from the mounds with the still more numerous flints from the cromlechs, I discovered that several of the rudest flint implements of the mounds never appear in the cromlechs or graves of the stone-age; and, on the other hand, that a great many of the highly finished or polished stones of the cromlechs never are to be found in the mounds. In Lectures delivered at the University of Copenhagen (1857), I tried to show that the rude flint implements of the mounds were exactly like some other rude and undoubtedly extremely old flint implements found in great abundance in different places on the sea-shores of Denmark, and also in Schonen, at the bottom of old bogs, which now are, and which probably for thousands of years have been, covered with large hills of gravel, clay, and sand, as well as remarkably like the rude hatchets, and other implements of flint, discovered under circumstances pointing to a very high antiquity, in different bone-caves in England and France, and in the gravel-pits at Abbeville and Amiens. Of these implements I had seen some at Abbeville, in the museum of M. Boucher de Perthes, who also afterwards, when more of them had been found, with great liberality forwarded several specimens for comparison to our Royal Museum of Northern Antiquities at Copenhagen. I extended my comparison to the implements of the very rudest savage tribes of America and the South Sea, preserved in different museums, and I came to the result, that the peculiarly formed, very rude flint implements of the mounds of Denmark, and of the bone-caves and gravel-pits of England and France, must belong to an earlier time of the stone-age than the cromlechs or large stone chambers; and that they, perhaps, are to be ascribed to some peculiar savage tribes, who were the real aborigines of the North and West of Europe, and who afterwards must have been subdued by more powerful, more advanced tribes, of whom the beautifully-finished stone implements, and the very remarkable, sometimes quite astonishing, stone chambers, or cromlechs, are speaking memorials. Last spring, at a meeting of the Royal Academy, I further explained this new subdivision of the stone-age, which was preceded by an equally new subdivision of the bronze-age. Six months ago I had succeeded in establishing a subdivision of the iron-age, in such a way that we, according to my opinion, now are enabled, for the Pagan time alone, to point out six different great periods of civilization in Denmark, and I dare say in a good many other countries of Europe.

This new system, however, especially the division of the stone-age, was naturally opposed by several antiquaries. When, a few months after, the news of

the discoveries in the Brixham cave, and the recent researches in the gravel-pits at Abbeville and Amiens, suddenly arrived, I was agreeably surprised at seeing the opinion of the very high antiquity of the rude stone implements found there, fully corroborated by the authority of eminent French and English naturalists and antiquaries; and I derived equally great satisfaction from the unanimous declaration of all the different writers in this case, that the flint pieces from the gravel and the caves are much unlike the common implements of the stone-age in France and England; and that they evidently are forming quite a peculiar class. Some remarks of Mr. Evans, in his paper communicated to the Society of Antiquaries of London "On the Occurrence of Flint Instruments in undisturbed Beds of Gravel, both on the Continent and in England," where he speaks about the pointed and oval, or almond-shaped implements of flint, "all indisputably worked by the hand of man, and not indebted for their shape to any natural configuration or peculiar fracture of the flint," attracted, in the highest degree, my attention. "They present," he says, "no analogy in form to the well-known implements of the so-called Celtic or stone period, which, moreover, have for the most part some portion, if not the whole, of their surface ground or polished, and are frequently made from other stones than flint. Those from the drift are, on the contrary, never ground, and are exclusively of flint. They have, indeed, every appearance of having been fabricated by another race of men, who, from the fact that the Celtic stone weapons have been found in the superficial soil, above the drift containing these ruder weapons, as well as from other considerations, must have inhabited this region of the globe at a period anterior to its so-called Celtic occupation."

It certainly is a very remarkable coincidence, that Mr. Evans here, without any connection with me, and without knowing my newly-started theories about the subdivisions of the different ages, is using exactly the same arguments, and nearly the same words, with which I, two years ago, tried to add a subdivision of the stone-age to my other proposed divisions of the bronze and the iron ages.

The flint implements of the drift and the bone-caves are no longer left "without any standard of comparison." We have plenty of such objects, hundreds, and even thousands, found in the said artificial mounds, in lakes, bogs, and on the sea-shores of Denmark, in the closest connection with antiquities of such a kind, that no man, not even the most prejudiced, should venture to ascribe the origin of them to a natural cause, to "motion in water."

The great quantity of flint implements found in the drift in the valley of the Somme in France — more than a thousand in the last ten years, in an area of fifteen miles in length — has been used as an argument against their being implements at all. But it must be borne in mind, that the aborigines, as naturally was to be expected, for the sake of fishing, lived near the sea-shore, the rivers, and lakes, and that they on the very spots where they wandered about, undoubtedly, very often through many centuries, manufactured their rude implements of flint, — a material which resists the influence of time. We, therefore, have the right beforehand of supposing a great number of stone implements to be found in such localities, and the truth of this supposition has also been completely confirmed by many most curious *facts*, which have been observed both in Europe and in America.

For instance, in the neighborhood, of Pittsburg, Penn., on the borders of the river Delaware, such a number of stone implements were found,

that from one locality several hundred arrow-heads and other implements of stone could be sent over to the Royal Society of Northern Antiquaries here. A distinguished Danish naturalist, — Dr. Lund, — who for many years has been residing in Brazil, mentions, in a letter to the said society, that the borders of the small lake Lagoa Santa, at the time when the Europeans first came to that part of Brazil, were all scattered over with hatchets of stone, proving that this spot had been a favorite one for the aboriginal inhabitants.

To these observations I could add a great many similar from the sea-coasts of the Continent, from larger and smaller Islands, as well as from the borders of lakes in the north of Europe, where rude flint implements in great abundance have been discovered. But I will only mention here, that in Denmark, in the island of Laaland, Mr. de Wichfeld and myself have been fortunate enough lately to collect in the course of a few weeks, in one locality, more than a thousand extremely rude flint implements, exactly like those from our oyster-mounds, and very similar to those found in the gravel-pits and bone-caves in France and England. They were lying spread partly at the borders of the small lake of Maribo, partly on small islands or holms in the lake, where some traces of pile-work (probably even older than that discovered in the lakes of Switzerland), for the first time in this country, have been found, and partly in the lake itself, in the very water near the borders. The lake has a length of five or six English miles, and a breadth of one or one and a half miles, and hitherto only one of the sides of the lake has been searched. The number of flint implements discovered here in a few weeks surpasses, comparatively, the quantity of similar implements found in ten years in the valley of the Somme.

A most interesting circumstance with this same remarkable find in the lake of Maribo is, that we have some reason to believe that the lake in the aboriginal time, perhaps, may have had another niveau than now, as there are to be seen in the lake standing roots of fir-trees, which formerly must have stood on dry, or at least on boggy ground. Several other circumstances from the same lake, and from different localities in Schonen and in Jütland, where the rudest stone implements have been discovered, make it very probable that our country, as well as England and France, must have undergone considerable geological changes, at least in some parts, and at a very remote time, when the poor savage aborigines wandered about on the sea-coasts, and on the borders of lakes and rivers, with their miserable implements of flint and bone.

I offer these comparative remarks in the hope that they may throw some light upon the great and important question of the day, — the question about the antiquity of the human race. I fully agree with Sir C. Lyell, "that the evidence is very strong in favor of a very high antiquity," as there really is no reason to doubt that true implements of flint, works of human art, frequently have been found in the drift with bones of elephants, rhinoceroses, and other extinct animals. I feel convinced that we are at the commencement of some of the most remarkable discoveries which have been lately made, and which certainly will have a great influence upon the further rapid progress of national archæology on the whole, and also upon its emancipation from old and new prejudices, and from so-called historical theories.

First Inhabitants of Switzerland. — Curious discoveries have recently been made of various stone instruments and other relics of an ancient and un-

known people, near the shores of several lakes in Switzerland and France. The *Revue Archæologique* of Paris noticed the first discoveries in 1854-55, and the January number of 1860 gives the results of later researches, with drawings of fifteen kinds of tools, weapons, etc., which have been found by hundreds. They have edges and points of stone, with handles of deers' horns, and have been preserved by being covered with water and the deposits of earth. Remains of piles and rough planks have been dug out, in railroad excavations, which have led the best archæologists to the following conclusions: there was a people who inhabited at least that part of Europe long before the historic period, who had no metals, and used stones, and sometimes bones, for tools, ornaments, implements, and weapons of various kinds, with deers' horns for handles to such as needed them. Some of these ancient people lived in small communities, in houses built on platforms of plank resting on piles, extending from the shores of lakes some distance over the water, from which they doubtless drew fish for their subsistence; but they had also a variety of other food. Specimens of pottery are found, generally cylindrical, and some with round bases, without feet; some have two holes for suspending them. Small bowls have been found, made of deers' horns. The numerous bones of animals discovered afford an interesting study of the fauna of the country at the remotest period of which there are any traces.

More recent lake habitations of the same kind have been found, where instruments of copper were found mingled with those of stone; and there are indications that the race which introduced the copper (probably Celts) conquered the original inhabitants.

M. Gastaldè has recently communicated to the Academy of Sciences at Turin an account of an exploration of a large peat moor, in the neighborhood of Lake Maggiore, in Northern Italy, made in connection with Professor Desor, of Neufchatel, to ascertain whether it contained any traces of subaqueous structures, such as have been found since 1854 in some of the lakes in Switzerland. Although unsuccessful in this respect, they found several fragments of pottery, and a canoe made of the trunk of a tree, all imbedded in peat, at the depth of a metre (thirty-nine inches). The antiquity assigned by the discoverers to these fragments, judging from the uniform accumulation of so great an amount of peat above the canoe, is at least one hundred years before the foundation of Rome.

On the Flint Implements found in the Drift.—In a paper read before the Geological Society, London, June, 1860, by Mr. Mackie, F. G. S., on the above subject, the author pointed out the evidence which exists that the flints thus found are worked by the hand of men, alluding especially to the uniform characteristics which are to be observed in the manner in which the flints, wherever discovered, are trimmed. This trimming is peculiar, and its constant recurrence negatives the inference that it could have been produced by any ordinary geological causes. He then dwelt upon the positions in which the flints have been found, from which it was apparent that they are, whatever their age may be, of the same age as the drift in which they are imbedded, and are in every sense of the word *fossil*. Mr. Mackie then noticed the flint flakes which have been discovered, and showed clearly that the peculiar uniform shape of these can be accounted for only on the supposition that they have been chipped off some larger block in a regular manner, and with some definite purpose. He pointed out the great geographical area over which these flints have been observed, and then adverted to the

possible uses to which they may have been put. He discarded the supposition that they were "celts," pointing out that a celt is radically different in form, being sharp at the wide and blunt at the narrow end, which is exactly opposite to what is observed in the implements under discussion. In fact a celt is a chisel, while these flints have apparently been used as weapons of offence, and were probably arrow-heads. The author mentioned the fact of an injury having been detected by Professor Owen in the fossil bone of an Irish elk, and pointed out the possible connection between such injuries and the implements under examination.

In a paper communicated to *Blackwood's Magazine* for October, 1860, under the title of "The Reputed Traces of Man Primeval," by Prof. Henry D. Rogers, of the University of Glasgow, the whole subject of the occurrence of the flint implements in the drift is ably reviewed, and all the adjunct circumstances connected therewith clearly stated. "They occur," says Professor R., who has personally made a scientific examination of the localities, "in not inconsiderable numbers in the gravel-quarries or sand-pits of Abbeville and Amiens, and also at a few spots bordering on the wide valley of the river Somme, more sparsely on the Seine, at Paris, and at one locality in England, namely, Hoxne, in Suffolk. It is estimated that the total number of these 'worked flints' exhumed since their first detection by their eminent discoverer, M. Boucher de Perthes, of Abbeville, some twenty years ago, exceeds fifteen hundred, and may even approach two thousand specimens."

"A preliminary conviction of the existence of the remains of antediluvian man induced M. de Perthes to labor ten years subsequent to 1838 in search of them, and though he found no human bones (which, we may remark, might have been preserved as well as the osseous structure of the extinct animals in the diluvium), he did strike upon these artificially shaped flints having marks of human origin. Of these, it appears, he published an elaborate description in 1847, which attracted but little notice until his deductions were approved by M. Rigollot, who, in a pamphlet, recanted his previous scepticism, and expressed his agreement with the conclusions of M. de Perthes. Other learned geologists in France and England followed on the same side, among them Joseph Prestwich, who, in 1859, read a paper on the subject before the Royal Society of London, and J. W. Flower, who submitted in the same year to the Geological Society a report on a flint implement discovered at the base of some beds of drift gravel and brick earth at St. Acheul, near Amiens. The wrought flint here referred to (which is figured in Blackwood) was found by the author lying at the depth of sixteen feet from the surface, and about eighteen inches from the face of the quarry, to which extent the gravel had been removed.

"The embedding structure, or place of sepulture, of the wrought flints, geologically regarded, is," says Professor Rogers, "for Abbeville, Amiens, and the other localities on the Somme, a rudely deposited, irregularly strewn bed of somewhat fragmentary chalk-flint, containing some flint-sand, a little pulverized chalk, and occasional large blocks or boulders, of a hard quartzose Eocene sandstone. This evidently diluvial matrix, the repository also of the bones of gigantic mammalian quadrupeds, rests directly on a somewhat uneven and eroded floor of chalk, out of the wreck of the upper beds of which stratum the nodules of flint forming the greater part of the gravel have been derived. It is overlaid in its turn by no less than three other strata, of aqueous origin, but all formed under dissimilar conditions.

"First above the bone and hatchet entombing gravel lies a grayish-white and brownish sand, imbedding several species of fresh-water and terrestrial shells, identical with species now living in this part of the globe. Though fine-grained, these sands bear the marks of a rather brief process of deposition, for portions of them are unusually angular, or unworn in the grain, and their laminæ in many places bend and wave to conform to the greatly eroded and undulating floor of the gravel on which they repose. Solitary specimens of the worked flints are, on rare occasions, met with in the lower part of these sands, and also, as rarely, the bones of the fossil elephant.

"Third in ascending order above the chalk occurs a second gravel, composed exclusively of chalk-flints in a rolled and more or less fractured condition. This bed, varying in thickness, at St. Acheul, near Amiens, from two to five feet, exhibits conspicuously at this locality the marks of having been deposited or pushed along in very turbulent waters; for its lower boundary, beheld in section at the gravel-pits, shows a succession of sharply-conical, and somewhat spiral, deep depressions in the upper surface of the sand beneath it, identical in every feature with the funnel-shaped pits bored by any strong, swiftly-eddying current in a yielding bottom of mud or sand.

"Fourth, and uppermost in the series of loose beds, is a brown brick-earth or ferruginous sandy clay or loam, interspersed with numerous small splinters of chalk-flint. At St. Acheul, and elsewhere near Amiens, where it is used extensively for conversion into bricks, this loam, which is but faintly laminated, is generally about three or four feet thick. Like the torrential gravel on which it rests, it is destitute not only of mammalian organic remains, but of the curious instruments in flint associated with them in the lowermost of the four superficial deposits. It does enclose some remains of another sort, which, when viewed in their relations to the vestiges of man beneath them, never fail greatly to impress the beholder by the contrasts they suggest in time and the state of human art. These are numerous Roman graves, or rather regularly-shaped stone coffins, of unquestioned Roman antiquity, oftentimes containing the skeletons of their inmates in a firm and well-conserved state. When the student of time, deciphering these four successive chapters in the physical history of our globe, drops his gaze from these tombs, — which descend but a small yard below the grass, yet take him back through almost one-third of the usually imagined lifetime of the world, — and lets his vision, pausing at intervals upon the monuments of alternate past ages of repose and epochs of turbulent floods, rest at last, some twelve or sixteen feet lower in the earth, on a physical record, to him as expressive as the graves above, of the past existence, near the same spot, of a race of men unacquainted with the metals, — what wonder, with his critical spirit prostrated before his imagination, that he should forget to scrutinize the evidence, and should quit the ground with the *sentiment* which he confounds with a *logical conviction* of the vastness of the ages covered by the record? His inquisitiveness keenly aroused by this impression, he interrogates afresh the pages of this stony register for other and more palpable proofs of the human beings, and the extreme age indicated in the objects he has beheld; and perplexed at the *total absence* of any traces of man himself, — of even a single human tooth, or fragment of a human bone, where other teeth and other bones no better capable of preservation are of common occurrence, — he withdraws a second time from the scene, cogitating many

doubts, and at last, under the suggestions of a philosophical scepticism, — the only right mood for analyzing the apparently contradictory evidence before him, — he asks himself the following questions: Are the flint-implements — these imputed products of man's skill — actually the work of human hands? Again, though they and the mammalian bones, held to be distinctive of the diluvium, do lie entombed together, does this demonstrate that the once owners of each — the men who left the flints, and the animals who possessed the bones — also *lived* together in the same epoch? Admitting that they were contemporary, how far does this fact of itself establish the great antiquity of the human race?

"And, lastly, apart altogether from the proofs of age, deduced from the association of the human relics with the remains of the extinct quadrupeds, what is the geological evidence of the extreme agedness of both in the nature of the deposits of sand, gravel, and brick-earth placed above them, and in the intimations these give us of the time occupied in their formation?

"Such are the more prominent queries suggested by the phenomena, and such, indeed, the actual questions asked every day of the scientific observer, by intelligent readers of the still very fragmentary literature relating to this new and strange archæologic problem."

In regard to the first question, Are the so-called flint implements really the result of human workmanship? Professor Rogers states that there can be no reasonable doubt upon the subject; and that it is now admitted, by almost every scientific man who has examined them, that they bear unmistakable evidence of having been shaped artificially.

In regard to the inquiry, Does the mere association in the same deposit of the flint implements and the bones of extinct quadrupeds prove that the artificers of the flint tools and the animals coëxisted in time? Professor Rogers answers: "That mere juxtaposition of itself is no evidence of contemporaneity; and that, upon the testimony of the fossil bones, the age of the human relics is not proven."

"It is sometimes asked by persons uninitiated in geology, and who have not examined the diluvium and superficial gravel, if the 'wrought flints' may not belong to historic times, and have insinuated themselves downwards from the soil into the stratum which now entombs them by mere force of incessantly acting gravity, either through chinks in the over-resting deposits, or between their fragments and particles. Preposterous as this question seems to the geologist or to the practical excavator of the subsoil, it is so often and so constantly advanced that it demands an answer; and our reply is, that a few minutes' inspection of the beds containing and overlying the flint-implements of the Somme will assure any observer that they are entirely destitute of the imagined crevices, and are, moreover, altogether too compact and immovable to admit of any such insinuation or percolation of surface objects. The gravel is, indeed, so firm, that a live mole, with all his admirable appliances for burrowing, could not possibly enter it; so firmly imbedded, that the workmen use heavy iron picks to disintegrate the half-cemented materials."

To the query, What is the antiquity of the mammalian bones with which flint-implements are associated? Professor Rogers' answer is, "that, apart from their mixture with the recently-discovered vestiges of an early race of men, these fossils exhibit no independent marks by which we can relate them to human time at all. Let us admit that the wrought flints are truly contemporary with the animals whose bones lie side by side with them, and

that the deposit embedding both is the general diluvium, or mammalian drift; do these facts of themselves determine the flints to have been fashioned in an age preceding the usually assigned birth of man? Logically, it must be conceded, they do not; for, independent of the absence or presence of these or other vestiges of man in the diluvium, its antiquity or relation to historic time is obviously not ascertainable. Apart from human relics in or over or under the drift, how can we link it on to historic time at all? Before the discovery of the flint-implements in this superficial formation, or so long as the traces of men were known only in deposits later than the diluvium, it was deemed to belong to an age antecedent to the creation of man, and had, therefore, a relatively high antiquity assigned to it; but now, granting that relics of men have been authenticated as buried in it, is it sound reasoning, we would ask, to infer for these relics the very antiquity which was only attributable to the diluvium because it was believed destitute of all such human vestiges? The diluvium of geologists has, since the days of the illustrious Cuvier, been always looked upon as something very ancient, simply because he and his successors, finding it replete with the remains of huge land mammals no longer living, never succeeded in detecting in it a solitary bone or tooth of a human being, nor, indeed, anything indicative of man's existence; but now that things indicative of man have been found, it is surely illogical, and a begging of the very question itself, to impute an age incompatible with the fact of his then existing.

"As matters now stand, is it not as rational to infer the relative recency of the extinct *Elephas primigenius*, and the other mammals of the diluvium, from the coëxistence of the works of men with them, on the ground that the human is a living and modern race, as it is to deduce the antiquity of man from the once erroneously assumed greater age of those animals? I would repeat, then, that a specially remote age is not attributable to the flint-carving men of the diluvium, simply because it is the diluvium, or mammoth-embedding gravel, which contains them. If their association with these extinct mammals *does* intimate a long pre-historic antiquity, the evidences of this are to be sought in some of the other attendant phenomena.

"The age, therefore, of the diluvium which encloses the remains of the extinct mammalian animals must now be viewed as doubly uncertain,—doubtful from the uncertainty of its coincidence with the age of flint-implements; and, again, doubtful, even if this coincidence were established, from the absence of any link of connection between those earliest traces of man and his *historic* ages."

As regards the question involved in this inquiry, What lapse of ages has it demanded to alter the surface of the globe, where these remains are found, from a state especially suited to the extinct antediluvian races, into that now prevailing? the data are altogether too indeterminate to admit of anything approaching a definite answer. "As in every other attempt to interrogate Geology, her response is Sybilline. She has two classes of votaries: one, entitled the *Uniformitarian* school, or *Quietists*, who, interpreting the past changes in the earth's surface by the natural forces, especially the gentler ones now in operation, overlook the more energetic and promptly-acting ones; and another, the school of the *Catastrophists*, perhaps more fitly defined the *Paroxysmists*, who, blind in the opposite eye, see only the most vehement energies of nature,—the earthquake and the inundation,—and take no account of the softer but unceasingly efficient agencies which gradu-

ally depress or lift the land, or silently erode and reconstruct it. By each of these her answers as to time are *differently interpreted.*"

"In conclusion, then, of the whole inquiry," says Professor Rogers, "condensing into one expression my answer to the general question, Whether a remote pre-historic antiquity for the human race has been established from the recent discovery of specimens of man's handiwork in the so-called diluvium, I maintain it is not proven; by no means asserting that it can be *disproved*, but insisting simply that it remains *not proven.*"

On some Bronze Relics from the Auriferous Sands of Siberia. — At a recent meeting of the London Geological Society, Mr. T. W. Atkinson, the well-known Asiatic traveller, stated, that during his stay at the gold mine on the River Shargan, in Siberia (latitude 59° 30′ north, and longitude 96° 10′ east), in August, 1851, some fragments of worked bronze were dug up by the workmen, at a depth of fourteen feet eight inches below the surface, from a bed of sand in which gold nuggets occur. This sand rests on the rock, and is covered by beds of gravel and sand, overlain by two feet of vegetable soil. The fragments appear to have belonged either to a bracelet or to some horse-trappings. This paper was discussed with great interest, as it tended to prove the existence of man, in a tolerably advanced condition of civilization, before the deposition of the strata containing the bones of the great mammalia. From the evidence collected by Mr. Atkinson, there was no doubt that the fragments were discovered in the situation exhibited in the drawings, which he made on the spot, and neither he nor the officers of the mines detected any appearance of disturbance in the superincumbent strata. It did not, however, appear that any minute examination was made by any geologist experienced in this kind of inquiry, and the general impression was rather in favor of assuming that the articles must have been conveyed by some unknown force from a more recent stratum to that in which they were found, than to believe that a race, sufficiently advanced in science to make works of bronze, existed in Siberia at a period so enormously anterior not only to the pre-historic time which archæologists have investigated, but even to that which geologists have assigned as the probable commencement of the appearance of man.

At the last meeting of the British Association, the Rev. Dr. Anderson, F. G. S., presented a paper, the object of which was to combat the idea that any of the recent geological discoveries can in truth carry back the creation of man to a period anterior to that assigned by the Mosaic chronology. He classifies into three divisions the cases which are relied upon by those who maintain the very remote antiquity of the human race. The first of these comprises the instances in which human relics have been found, thickly incrusted in a matrix of stony matter, in the calcareous breccias and strata now in process of formation. There is, he contends, no evidence whatever that the relics discovered in such situations as these were deposited at a comparatively recent period. Instances are of not unfrequent occurrence, especially on the southeast coast of England, in which flints are found enclosing coins, fragments of bolts, anchors, etc., and other human relics, the stony covering of which has so completely the aspect of true rock-substance as to warrant at first sight the conclusion that its deposit has been the work of countless ages; but, on removing the flinty matrix, the coin is found to bear the head of an Edward, a James, or even a George, and the bolt or anchor to be stamped with the mark of some still-existing firm. Facts like these prove that the incrustation of relics deposited by a shipwreck or other-

wise, in a sea which washes a chalk or limestone coast, is an operation requiring much less time than from outward appearances would generally be supposed. Petrifying springs are notoriously not less rapid in their action. Dr. Anderson quotes an interesting and apposite instance in which operations are actually going on, which would be quite sufficient to account for many puzzling and abnormal appearances. It occurs on the coast of Fifeshire, between Burntisland and Aberdour, where the overhanging cliffs are thickly planted with trees and underwood, and deeply covered with a coating of calcareous breccia. In many places, branches of trees are enclosed in the calcareous matter, and "on the face of the rocky cliff a portion of a branch may be observed entangled in the breccia, and at the same time attached to its parent tree." Now, not only may a boulder containing a branch of a tree be carried by the waves to a spot at a considerable distance from the place of its formation, but the breccia in which the branch is enclosed may also contain in its matrix fossil shells of a bygone period, — a juxtaposition of old and new, which might not improbably puzzle the observer by whom it was found to assign a date for its origin.

The second division includes those cases in which human relics and works of art have been found in the silt of rivers, in morasses, or in the superficial soils of the earth. One of the most striking of these is the discovery of a piece of pottery in the bed of the Nile, near the ancient city of Memphis, at a depth of thirty feet under the lowest point of the platform on which was subsequently erected the colossal statue of Rameses II. When this case was brought before the British Association, at Leeds, the inference drawn from it was that the fragment must have been made at least thirteen thousand years ago. Dr. Anderson, however, disputes this conclusion, on the ground that the whole track of the Nile through Lower Egypt has been subject to such successive changes of level as to render any comparison between the past and present rate of silt-deposit along its bed quite impossible. In support of this view he cites some observations made by Dr. Buist, in a paper on the "Geology of Lower Egypt," in the Bombay *Journal of Science*, which are so interesting or apposite that we cannot do better than extract them entire: —

"A principle, says Dr. Buist, that seems to have been too often lost sight of in the formation of deltas, should be constantly kept before us. No delta could ever rise permanently above the surface of the inundation at all, by the agency of setting up exclusively, and unless there was an upheaval of the land or subsidence of the water. At Cairo, the deposit of each flood is as thin as a sheet of drawing-paper; when this accumulation goes on till it has reached within a few inches of the highest inundation, it must become evanescent altogether. Neither Alexandria, Cairo, Calcutta, Hyderabad in Scinde, New Orleans on the delta of the Mississippi, nor any other deltoid city, could ever have found a site at all, unless by upheaval; and so with the sites of the villages from Cairo to the sea, and the bulk of the area of the delta which the Nile, even at its highest floods, now never reaches. Yet these are all composed of river-mud, of exactly the same description as that now being deposited.

"If this, which is not a hypothesis, but a principle, be kept in view; and if it be remembered how much more rapidly mud is precipitated in stagnant than in running water, it will be at once seen that the rate at which alluvium now accumulates on deltas, merely overlaid by a shallow film from the surface of the streams, affords not the slightest grounds for drawing conclusions

as to the time taken for the accumulation of the whole mass, laid down, as it must have been, under circumstances utterly unlike those now existing. The mud of the old delta of the Nerbudda, in Guzerat, now forming a bank of seventy feet in thickness, the surface of which, above Broach, twenty miles from the Gulf of Cambay, is thirty feet above the highest flood, divides into flakes of from one-fourth to one-eighth of an inch; and yet we are not certain that each of these may not be the deposit of a single freshet of a few days' or hours' duration, rather than the accumulation of an entire season.

"The layers of sharp desert sand, seen in many places on the banks of the Nile below Cairo to alternate with the mud, may probably have been deposited on the dry surface of the soil, during some of the movements referred to. A descent of the land, after this had occurred, would permit the mud, now lying many feet in thickness over them, to be deposited without disturbing them; running water would have removed the sand, and mingled it with the mud. The extreme abruptness of the transition from delta silt to desert sand, from extreme fertility to absolute barrenness, astonishes the stranger; near the pyramids you may actually, and without figure, have one foot on arable land, and the other ankle deep in desert sand."

With regard to the remains found in morasses and peat-mosses, Rennie, in his essay "On the Natural History and Origin of Peat-moss," has shown that the rapidity of growth of these deposits is so great as to have produced an immense mass of accumulation during the time which has elapsed since the Roman invasion; Roman roads and causeways being frequently traceable for miles among the mosses of Annandale, Lanark, and Perthshire. The well-known case of the Guadaloupe skeletons, which were found imbedded in hard limestone, among the detritus of sand, shells, and corals, at the base of steep cliffs on the northeast coast of the island, and which are now generally considered to be those of a tribe of natives, which was slaughtered by a hostile tribe and buried on the sea-shore not more than one hundred and fifty years ago, would seem to belong to the former rather than to the present division, in which Dr. Anderson has placed it.

Under the third head are included the remarkable bone-caves which have been found, often at a considerable elevation above the sea, in various parts of the British islands, in the neighborhood of Palermo, and in other places, in which human bones, together with flint implements of human manufacture, have been found in company with the remains of carnivorous animals of great size, some belonging to genera which have been long extinct. The argument which has been grounded on these discoveries depends upon the conclusion that these human and animal remains must necessarily be of contemporary origin. According to Dr. Anderson, this conclusion is not only no necessary sequence from, but is actually inconsistent with, the observed facts. If the human beings and carnivorous animals whose bones are now found mingled in one common tomb had ever been alive together, we should have expected to find the remains of the former gnawed and broken; a condition in which, apparently, they do not occur. Dr. Anderson concludes that these caverns, already containing the fossil remains of animals, were from time to time used as habitations by men. Their elevation above the sea he accounts for by the upward movement which, as is now well known, the coast-lines of many countries are even at this moment undergoing; and he further suggests that such upheaval, if sudden and rapid, as in the neighborhood of volcanic centres at least it might well be supposed to be, would cause fissures in the rocks, into which a mixture of

fossil remains of very different dates, made by some such process as that indicated in speaking of the first division, might subsequently have been deposited.

Such are the reasons on which Dr. Anderson bases his conclusion, that there is nothing in recent geological discoveries to warrant a departure from the usually accepted date of man's recent introduction upon the earth.

ARE THE COAL-MEASURES A SINGLE, UNIQUE FORMATION?

Are the coal-measures a single, unique formation? Do they belong to a single epoch, or are they composed of a succession of formations, separated by immense spaces of time, and of which the different stages might be compared to those of the recent formations: the Eocene, the Miocene, and the Pliocene, for example? In the last case, can we admit the vegetation of which the remains have been preserved in the shales of the coal, or the vegetation of the coal-marshes, as a true representative of the flora of the various epochs where the coal was formed? Or was it then, as the bog-vegetation is in our time, composed of a peculiar group of plants, adapted to the formation of the coal, pertaining to the marshes only, while another flora, of a different character, was covering the dry land, if there was any dry land, at the carboniferous epoch?

From the thickness of some beds of coal, representing a mass of combustible matter as great at least as that which is contained in our oldest and deepest peat-bogs, from the thickness and various composition of the strata which separate the beds of coal, and from the successive changes in the vegetation of the coal, it appears that the last alternative is admissible. Different hypotheses have been put forward to explain the so-called huge or gigantic vegetation of the coal formations. But there is nothing in the carboniferous epoch authorizing the suppostion that the power of vegetable life was greater than it is at our time. The combustible matter heaped in some of our peat bogs is sometimes sufficiently thick to be equivalent to the coal of a bed of four to five feet. The trees growing in our marshes or on the peat bogs are generally larger than those which have been preserved in the strata of the carboniferous measures. The Dismal Swamp is impenetrable on account of the great compactness of its vegetation. It is not an easy matter either to get across the heaped, half prostrated, or erect and closely pressed trees of our cedar-swamps of the North. If such marshes were extended over the greatest part of the United States, they would present a fair representation of those of the carboniferous period.

The occasional appearance of the petrified trees, standing imbedded in sandstone, does not give evidence of a rapid formation either of the coal or of the other strata. Local disturbances may throw a few feet of sand upon a marsh, covered with active vegetation, and thus preserve the stumps from decomposition, and by-and-by these may be converted to stone. The bald cypress and other species of trees grow sometimes in the marshes near the sea-shore under ten feet of water. Whole forests of those trees have been imbedded in a standing position in the marshes around New Orleans. Thus I do not find in the geological records of the carboniferous period any indication of a rapid process of formation, either cataclysmic or abnormal, and I readily admit that each bed of coal, with its accompanying strata of fireclay and shales, has required for its formation a period of time as long as any of our recent geological divisions.

The question concerning the existence or non-existence of dry land covered with a peculiar vegetation at the epoch of the coal formation, cannot be answered positively or negatively by sufficient evidence. The only fact that would indicate that the marshes of the carboniferous epoch were surrounded by land-bearing plants of different kinds than those living on the bogs is the presence in coal and in sandstone underlying it of a great number of fruits of different species which by their nature have no relation to any of the other remains preserved in the coal. They have been generally referred to species of *Cordaites*. But the two only species of our coal measures are found in abundance at geological horizons where the fruits are entirely absent. And even coal shales appearing entirely composed of heaped remains of leaves of *Cordaites borassifolia* do not contain any fruit. The species of fruit, *Carpolithes Cordai* Gein., referred by M. Geinitz to *Cordaites borassifolia*, our most common and omnipresent species, has not been found in the coal measures of America. Therefore, either the fruits of unknown relation belong to vegetable species which have grown on the marshes, and of which the remains, leaves and stems, have been entirely obliterated, or those fruits belong to species growing out of the marshes, around them, and have been floated, and thus disseminated in the shales and in the sandstones. This last opinion appears at first confirmed by a similar process of distribution of species in our deep swamps; as the hollow trunks of the bald cypress which grows in Drummond lake (Dismal Swamp of Virginia) are filled by fruits, acorns, nuts, etc., of trees which grow on the dry land near its borders. But it is not presumable that species of fruits only could have been floated and disseminated by the agency of water, without any of the branches and of the leaves of the plants to which they belong. And nowhere have the shales, covering what is called the tail of a coal bank, viz. the part abutting against a hill of sand or losing itself in sandstone, exposed any remains of plants of another type than those belonging to the true coal formation. Even where the shales of the coal are covered with remains of shells and of fishes, and consequently formed when the marshes were immersed, all the floated remains of plants which are found with those of animals belong to the common species of the coal. I believe, then, that the plants preserved in the shales of the coal give us a fair representation of the general flora of the carboniferous epoch, as true and as general at least as the fossil plants of the Miocene represent the general flora of the tertiary period. And I suppose that if there was any dry land around the marshes, the vegetation contained only a few species different from those living on the marshes. But this last opinion is merely hypothetical. — *Leo Lesquereux, Silliman's Journal, Nov.* 1860.

CORRESPONDENCES OF THE AMERICAN AND EUROPEAN COAL-FLORA.

Considering its generic distribution, the American coal-flora is nearly related to the European. We have only two or three peculiar genera, representing distinct types, which have not been seen in Europe. On the contrary, Europe has no true and generic types of coal-plants which are not represented in the coal-fields of the United States.

Considering its species, a more marked difference in the coal-flora of both continents becomes evident. Some of our species represent marked and peculiar forms or types, which are not seen in Europe, though a much

greater number of species has been found in its coal measures. Thus the predominance of typical or distinctly characterized forms belongs to our country. By comparison of the flora of our epoch on both continents, we find now the same proportional relation and difference as at the time of the coal formation, that is, on this side of the Atlantic a predominance of well-marked types; a predominance of species of trees;[1] a number of species perfectly identical on both continents, and many American species so nearly related to European congeners that their specific characters can hardly be established.

Though further researches ought necessarily to increase the number of species of fossil plants belonging to our coal measures, the proportional difference is likely to remain as it is established above.

The fossil flora appears identical at the same geological horizon over the whole extent of our coal-fields. This proves uniformity of stratification and geological unity of the different coal basins of America.

The first trace of vegetable terrestrial life appears in the middle of the Devonian in a species of *Lepidodendron*, represented by its bark, its leaves, its cones, and large trunks of silicified wood. No remains of any other form of terrestrial vegetation have been seen in strata either inferior or contemporaneous to this. All the vegetable remains known in the Silurian and lower Devonian belong to species of fucoides or marine plants, mostly of small size, resembling some species of *Fucus* of our time. The first leafy terrestrial plants appear in the Old Red sandstone. All the representatives of this new vegetation belong to a peculiar genus, *Noggerathia* Göpp., more related to Conifers or even to Palms than to Ferns. They are found in the same geological horizon, both in Europe and in America, and entirely disappear at or before the beginning of the coal epoch. — *Leo Lesquereux, Silliman's Journal, Nov.* 1860.

INTERESTING GEOLOGICAL SPECULATION.

The late Professor Edward Forbes, in his work on the Natural History of the European Seas (which was left uncompleted at his death five years ago, and which has been completed, and published during the past year, by Robert Godwin Austen, F. R. S.), gives a curious and interesting instance of the method by which zoölogical studies may be brought to bear upon the facts of geology. The fauna of Vigo Bay, an arm of the sea which extends inland some sixteen or eighteen miles on the northwestern coast of Spain, is found by Mr. M'Andrew to be far more nearly related to that of the British seas than to that of the region in which it is situated. Now, it had already been noticed by Professor Forbes, some years ago, that the flora of the western coast of Ireland was in many instances identical with that of the Asturias on the northwestern coast of the Spanish Peninsula. We cannot suppose that the seeds of these Spanish plants were conveyed to Ireland by Rennel's current, for in that case traces of them would also be found in the southwestern counties of England, which is not the case; nor that they were conveyed by the winds, for the plants which are common to the two countries are precisely those whose seeds are not well adapted for such diffusion. In order, therefore, to account for this singular identity between the floras of

[1] The distribution of the genus *Lepidodendron*, at the time of the formation of the coal, has some analogy with that of the oak in our time.

two countries now separated from each other by so wide an expanse of ocean, Professor Forbes suggested that, at a distant period, the Spanish peninsula extended far into the Atlantic, past the Azores, and that its northern boundary was contiguous to, if not continuous with, the coast of Ireland; in which case the migration of the Spanish flora would be a very simple matter. The alteration in climate, caused by the geological changes which were contemporary with or subsequent to the destruction of this land, destroyed the mass of this southern flora remaining in Ireland, leaving only a comparatively small number of the hardiest plants. An important confirmation of the truth of this theory is afforded by the discovery of a northern fauna in Vigo Bay; since the species of which this fauna is composed are such as belong to the littoral and laminarian zones, and therefore could only have been transmitted along coasts presenting a line of rock or hard ground. As to the period at which this upheaval of land between Spain and Ireland occurred, Professor Forbes fixes it as immediately after the close of the Miocene epoch, a period which we know from independent evidence to have been marked by very considerable geological changes.

Nor is this the only instance in which the investigation of the existing fauna of the European seas has led to important conclusions respecting the distribution of land and water in remote geological ages. From the specific identity of the littoral molluscs, which are now found both upon the European and American coasts of the northern Atlantic, Professor Forbes concludes that there must anciently have been a continuous coast-line, along which these species migrated, probably from west to east; in other words, that, at some former period, the north of Greenland was connected with the north of Lapland by a belt of land, which cut off the communication between the Arctic and Atlantic oceans. This supposition is, later in the volume, confirmed by Mr. Godwin Austen on palæontological grounds. The existing fauna of the European seas dates back to the times which immediately followed the Eocene or Nummulitic period; not a single Eocene form occurring among the species at present in existence. The oldest records of the occupation of the Atlantic by any existing forms are found in certain beds scattered over the west of France, known as the Faluns of Touraine. A considerable proportion of the fossils of these deposits belong to existing Atlantic species; but they are now found, not on the French coast, but in localities several hundred miles further south. A precisely similar phenomenon is presented by some old sea-beds near Selsey, on the Sussex coast. Existing northern forms are not found among the fossils of these old deposits. These facts tend to prove that, in former times, the climate of the whole Atlantic region was much warmer than it is now, and that the same forms which are now confined to the southern regions then extended to a considerably more northern limit. Now this is precisely the effect which would be produced by such a separation between the Arctic and Atlantic oceans as that suggested by Professor Forbes. The warm waters of the gulf-stream, unchecked by encountering the cold arctic current, would in that case sweep up to the northern limit of the Atlantic, and the temperature of the whole of that region would be materially raised. When, by the agency of the same geological changes which upheaved the sea-beds of Touraine and Sussex, the belt of land between Greenland and Lapland was removed, and the cold arctic current admitted into the Atlantic Ocean, its present character would be committed to the North Atlantic fauna, both

by the destruction of many southern species and the introduction of many northern forms, which had hitherto been confined to the Arctic Ocean.

ON THE FOSSILS OF DURA DEN, SCOTLAND.

Dura Den is a small valley in the northeastern district of Fifeshire, Scotland, which has long been classic ground with British geologists, both on account of the lithological character of the Devonian sandstones there developed, and the number of fossil remains found in them. These last belong almost exclusively to that class of ganoid heterocercal fishes, the presence of which is so distinguishing a characteristic of the Devonian epoch.

The following extract from a monograph of the fossils of Dura Den, by the Rev. John Anderson of Scotland, published during the past year, will convey some idea both of the number and of the extraordinary state of preservation in which the fossils of this deposit are not unfrequently found:—

"The remains of these fishes are so very abundant in the yellow sandstone deposit of Dura Den, that a space of little more than three square yards, when the writer was present, yielded about a thousand fishes, most of them perfect in their outline, the scales and fins quite entire, and the forms of the creatures often starting freely out of their hard stony matrix, in their complete armature of scale, fin, and bone. This peculiarity of entireness, and even of freshness, in these olden denizens of the waters, is so remarkable, that, when first exposed to view in the newly split-up rock, there is a lifelike glistering over the clear, shining, scaly forms, so that one can scarcely divest himself of the idea that, instead of the innumerable series of geologic terms to be counted, he is looking actually upon the creations of yesterday, the relics of things that had just ceased to breathe. 'Here is a living one!' exclaimed a workman, as he raised from the bed of a river a large flagstone, in which were counted upwards of fifty fishes, one preëminently full, beautiful and rounded in its form. Indeed, the most splendid representations of an Audubon, a Gould, or a Landseer, on their glossy canvas, will shrink in comparison beside these pictures of nature-painting, brighter than the dyes of the artist, as set in their stony tablets, and contrasting finely with the rich saffron-colored rock, in which, uninjured and unstained, they have hung for ages."

EARTHQUAKE IN NEW ENGLAND AND CANADA.

One of the most severe shocks of an earthquake experienced for many years in the northern portions of the United States, and in Canada, occurred on the morning of October 17, 1860. In the northern part of Vermont the motion was sufficient to jar open fastened doors, ring the church bells, and in one case, at Northfield, Vt., a church spire was thrown out of position by the force of the shock, and in another, at Brattleboro', a house was cracked in two. In the vicinity of Quebec, the shock was also sufficiently powerful to occasion much alarm and produce some injury.

ON THE EXISTENCE OF THE "TACONIC SYSTEM."

Prof. E. Emmons, in his geological survey of Lake Champlain, as far back as 1838, recognized below the Potsdam sandstone a series of strata, which he

described at length in 1844, and named the *Taconic System*. The arguments of Prof. Emmons for the existence of this system were based on certain fossils, and on stratigraphical and lithological grounds, which to him appear good and sufficient reasons. His views, however, have been almost universally rejected by American geologists, and of late but little has been said on the subject. Recently, however, the matter has been brought up in the Boston Society of Natural History by M. Marcou, who supports the views of Dr. Emmons, and adduces the testimony of M. Barrande, the well-known European palæontologist, also in confirmation of them. M. Marcou says the discovery of *Paradoxides Harlani* at Braintree, Mass., and that of *Paradoxides Bennetti* and *Conocephalites* at St. Mary's Bay, Newfoundland, in slates until then regarded as Azoic and placed among the crystalline and primary rocks, show plainly that the Primordial fauna (recognized in Europe as existing before the Silurian epoch) is represented also on the Atlantic coast of North America. These are not isolated facts, but rather two landmarks showing the existence of strata occupying an important place in the system of stratified rocks.

M. Barrande, in a letter to M. Bronn of Heidelberg, also takes the position that the remains of certain species of trilobites, found in that part of the Taconic system of Emmons which is referred by other geologists to the Hudson River shales, are so unmistakably decisive in their character, that any European palæontologist familiar with these fossils would, without doubt, refer them to the formations which are recognized as being older and inferior to the Silurian System. "Such is my profound conviction," says M. Barrande, in his letter to M. Bronn, "and I think any one who has made a serious study of the trilobitic forms and of their vertical distribution in the oldest formations will be of the same opinion. Besides, all who have seriously studied palæontology know well that each geological epoch, or each fauna, has its proper and characteristic forms, which, once extinct, reappear no more. This is one of the great and beautiful results of your immense researches, which have generalized this law, recognized by each one of us within the limits of the strata he describes. The great American palæontologist arrived long since at the same conclusion, for in 1847 he wrote the following passage in the *introduction* to the first volume of the Monumental Work consecrated to the Palæontology of New York. 'Every step in this research tends to convince us that the succession of strata, when clearly shown, furnishes conclusive proofs of the existence of a regular sequence among the earlier organisms. We are more and more able, as we advance, to observe that the Author of nature, though always working upon the same plan, and producing an infinite variety of forms almost incomprehensible to us, has never repeated the same forms in successive creations. The various organisms called into existence have performed their parts in the economy of creation, have lived their period, and perished. This we find to be as true among the simple and less conspicuous forms of the Paleozoic series, as in the more remarkable fauna of later periods.'—*J. Hall, Pal. of New York*, i. p. XXIII. When an eminent man expresses such ideas so eloquently, it is because they rise from his deepest convictions. It must then be conceived that J. Hall, restrained by the artificial combinations of stratigraphy previously adopted by him, has done violence to his palæontological doctrines, when, seeing before him the most characteristic forms of the *Primordial fauna*, and giving them names the most significant of this first creation, he thinks it his duty to teach us that these three trilobites

belong to a horizon *superior* to that on which the second fauna is extinguished."

This is certainly very strong language, and it would be not a little remarkable if, after all the discussions and examinations of this subject, and after the all but universal condemnation of Dr. Emmons's views, geologists should finally be compelled to acknowledge that he is entirely in the right.

BOTANY.

ON THE GROWTH AND HABITS OF THE FUNGI.

A VALUABLE contribution to botanical science, published in London during the past year, entitled "Outlines of British Fungology; containing Characters of above a Thousand Species of Fungi, and a Complete List of all that have been described as Natives of the British Isles," by the Rev. M. J. Berkeley, is made by the London *Athenæum* the basis for the following popular and instructive article.

The fungus is a kindly friend, a fearful foe. We like him as a mushroom. We dread him as the dry-rot. He may be preying on your roses or eating through the corks of your claret. He may get into your corn-field. A fungus has eaten up the vine in Madeira, the potato in Ireland. A fungus may creep through your castle, and leave it dust. A fungus may banquet on your fleets, and bury the payment of its feast in lime. Fungi are most at home upon boles of old trees, logs of wood, naked walls, pestilential wastes, old damp carpets, and other such things as men cast out from their own homes. They dwell also in damp wine-cellars, much to the satisfaction of the wine-merchant when they hang about the walls in black powdery tufts, and much to his dissatisfaction when a particular species, whose exact character is unknown, first attacks the corks of his wine-bottles, destroying their texture, and at length impregnates the wine with such an unpleasant taste and odor as to render it unsalable; more still to his dissatisfaction when another equally obscure species, after preying upon the corks, sends down branched threads into the precious liquid, and at length reduces it to a mere *caput mortuum*.

In addition to such congenial places as these, we find fungi where no one would have expected them; as on our window panes and the lenses of microscopes, and even on smooth metallic surfaces. Not many years ago it was a decided saying, even amongst men of some pretensions, that fungi could not grow upon healthy substances; it is, however, now sufficiently established that the most healthy tissues may be affected by them so as rapidly, under their influence, to become diseased. They are not uncommon on the dressings of amputated limbs, and have led to ill-grounded charges of chirurgical negligence; and it is singular that they are capable of growth in substances which are, in general, destructive of vegetables, such as tannin, and many species prefer spent tan to almost any other substance. More than one species of fungus is developed on extracted opium,

and the factories in India have greatly suffered from their presence. Solutions of arsenic, sulphate of iron, and sulphate of copper, though highly concentrated, do not prevent the growth of some fungi of a low order, though they are at once destructive to other species. An obscure kind of mould is sometimes developed in Madeira wine, and a few years since a little mould was discovered in the solution of copper employed for electrotyping in the department of the Coast Survey of Washington, and proved an intolerable plague to the men of science. Rapidity of growth as well as locality is very remarkable in certain species. Fungous mould will sometimes appear in the inside of bread a few hours after it has been baked, as was once notorious with the coarse "*pain de munition*" or barrack bread at Paris, in which a beautiful red mould appeared in an incredibly short time. It was found upon examination that the spores (reproductive cells) of certain fungi would endure moist heat equal to that of boiling water without parting with their power of germination. Perhaps the most curious habitat of a fungus was that discovered in America by Schweinitz, viz. a piece of iron which had been red hot only a few hours before. Mr. Berkeley answers for the true nature of this product, as he possesses a portion of the original specimen. He has seen specimens of another species growing on a leaden cistern at Kew, from which it could derive no nutriment. No depth that man can descend to seems too deep for these plants, and we, ourselves, have discovered a luxuriant crop of them fifteen hundred feet underground, in one of the deepest coal-mines. No height that man can ascend to seems too high for them, and they appear in due and different orders in the hissing hot valleys towards the base of the Sikkim Himalayas, while higher up are subtropical species, and as you ascend, multitudes of species identical with, or closely allied to, northern European species; nor do they cease until they reach an altitude of eighteen thousand feet. Of cockney heights it may be mentioned that a particular species has been found on cinders, in about the last habitat we should expect, — on the outside of the dome of St. Paul's.

It is very difficult to say where fungi may not be found, since they are sometimes developed in situations apparently excluded completely from the external air, as in the potato mould, in cavities of the fruit of the tomato, in hazel-nuts, and even in an egg. How they have gained entrance to such habitats it is impossible to say, though it is known that the spawn of fungi has found a hidden pathway through the closest structures. The depth to which fungous spawn penetrates, and the speed with which it spreads, are often astonishing. In a few months, and in a damp situation favorable to the development of fungi, the most solid timber will sometimes show unequivocal traces of spawn. Elm trunks, which were perfectly sound when felled, have been penetrated by the end of the second year with spawn to within a few inches of the centre; and, in this instance, vegetation must have proceeded in the trunk for nearly twelve months before any fungi could establish themselves. The growth and extension of the too famous dry-rot are known to everybody. In fir-built ships it is the species of fungus named *Merulius lacrymans*, while in oak-built ships it is the *Polyporus hybridus*. Instances have occurred in which dry-rot has penetrated solid structures of brick. It is curious that the spawn of this fungus can often elude and defy the artifices and skill of the most sagacious human being. It can eat out the heart of his ships and the foundation of his houses. This almost intangible product of one of the lower orders of vegetation can silently render most fragile what was once most solid, can sap the very floor on which man

stands, the very table round which he gathers his family and friends, and the very couch on which he reposes. While he sleeps, it grows; while he rests, it advances; while he is at peace with all the world, it may be at war with him; and while his "wooden-walls" are calmly riding at anchor, unless he has taken all due precautions, and employed approved preventives, this despicable fungus will prove itself a secret foe, more formidable, perhaps, than the open, hostile array of a mighty nation. Wonderful are the powers of man to subdue nature to his service; wonderful is the mechanical genius of this great nation; wonderful is the penetrating power of conical bullets and modern shells,—but it may not be extravagant to affirm that the little dry-rot fungus, in its silent ravages, is more wonderful still, more penetrating, and, when once firmly established, more difficult to repel and dislodge. England may smile at an invasion of Frenchmen, but she might well tremble at an invasion of funguses!

Ireland, indeed, has already trembled at such an invasion, if it be correct to attribute the Potato Murrain to fungous growth. At all events, Mr. Berkeley remarks,—"In potatoes affected with the mould which bears so great a part in the production of the Potato Murrain, I have seen instances in which the tissues were almost entirely replaced by the spawn of the fungus. In fact, this spawn attacks the tissues of the plant in almost every direction, being present in the tubers and stems as well as in the leaves. It has a peculiar property of causing speedy decomposition of the tissues with which it comes in contact, and hence induces rapid—sometimes inconceivably rapid—decay." Nor are the remedies otherwise successful applicable in this case, and, at present, we cannot be said to know anything which effectually checks its progress, although almost numberless plans have been suggested. A formidable host of fungous foes is known under the general names of Smut, Bunt, Mildew, Rust, and Ergot, and the more particular designations of the Hop Mould, the Rose Mildew, and the Vine Mildew. The cultivation of the vine has almost entirely ceased in Madeira from this cause, and it is everywhere precarious. Hundreds of similar foes attack hundreds of other plants, and not only plants but animals, so that a large treatise has been written by Robin illustrative of their effects upon the latter. Certain species of fungi are promoters of diseases, and although it is not probable that they actually originate disease, it is pretty certain that they frequently aggravate it. The influence of others in the promotion of certain cutaneous disorders is now placed beyond all doubt. Insects are probably more injured by particular fungi than other members of the animal kingdom. Some of them attack insects in the pupa or larva state, and, as it is thought, while they are still living. One West Indian species is developed on a perfect wasp, which flies about with its vegetating burden until the latter grows too heavy for it, and weighs it down to death like an overburdened Sinbad. Our author believes this to be fact, upon the authority of one who has had an opportunity of ascertaining the real state of the case. While this species has such a remarkable power of weighing down, others, as the common mushroom, have an equally remarkable power of lifting up, so that it is asserted that large flagstones have been raised by their irresistible increase.

We have certainly some compensation for this destructive efficacy of the fungi in the circumstance that several of them are edible. If they frequently destroy our food, they might also frequently contribute to it, if wisely selected and pleasantly served. Being highly nitrogenous, we should expect

them to be highly nutritive. Not only do savage tribes, like the Fuegians, adopt particular species as their staple food during many months, but civilized Europeans consume them largely when fresh, and preserve them in casks for winter solace. Yet, even respecting these trifles and truffles, there are singular national prejudices; and we, who never scruple to eat the true mushroom, may be surprised to learn that the Italians carefully exclude this species from their markets; while, on the contrary, with the exception of the truffle and the morel, it is said to be almost the only one which is allowed to be exposed for sale in Paris. Both there and at home these three kinds of fungi are important articles of commerce. The extent to which mushrooms are employed in the form of ketchup will be quite surprising to those who have never given a thought to the subject. A single ketchup merchant, in consequence of the enormous produce of mushrooms during the present season, had no less than eight hundred gallons of this savory sauce in stock; and the whole has been prepared from mushrooms collected within a radius of some three or four miles.

It would seem odd enough that any one should become enthusiastic about funguses in relation to food; but they who wish to recreate themselves with such enthusiasm should consult Dr. Badham on the "Esculent Funguses of England" and his twenty plates of those which may be safely eaten. A lady also displays a like *furor* for funguses; and there are no less than one hundred and forty colored plates in Mrs. Hussey's "Illustrations of British Mycology," besides some excellent receipts and a great variety of information, the result of actual experiment.

A curious origin is attributed to a species of agaric eaten at Naples (*Agaricus Neapolitanus*). A few years ago the nuns of a certain convent in Naples were in the habit of throwing their coffee-grounds into the shady corner of their garden after each day's meal. A new species of mushroom was observed to shoot up from this substance while in a state of fermentation. Having been found excellent food, its cultivation has spread rapidly over different parts of Italy, according to Quatrefages, who is our authority, and it has since become customary to raise this esculent fungus in many parts of Naples in an unvarnished flower-pot, which is constantly kept in the shade, and in which coffee-grounds are collected. From this soil mushroom-like funguses shoot up in about six months. This may be a mere state of some common form of fungus. Another kind (Polyporus) is raised for food in Italy from hazel-stumps, by partially cleaving them, and then supplying them with a proper quantity of water. A certain species (*Polyporus tuberaster*) springs up in Italy from conglomerated masses of earth and spawn, called Fungus-stone (*Pietra Fungaja*), when placed in a conservatory.

There are also economical as well as edible uses for some species of fungi, as for snuff, for German tinder, for dyes, for anæsthetic properties like those of chloroform. Operations, indeed, have been successfully performed under such influence. Some can be employed for intoxication, some to destroy flies, and others make excellent razor-strops — probably from containing minute crystals hard enough to act upon the steel. The turners at Tunbridge Wells can get a beautiful green tint from the spawn of one species. Medical science likewise can find something in this order of plants. Ergoted grain, which owes its origin to a fungus, is a most valuable medicine in the hands of the regular practitioner, and most dangerous when abused. Domestic affairs are indebted to fungi to some extent, since an important use is made of a particular condition of certain species of mould in the preparation of

fermented liquors under the form of yeast. This consists of more or less oval bodies, which continually give off joints so as to produce short, branched, necklace-like threads. These joints fall off, and rapidly give rise to a new generation, which is successively propagated till the substance is produced which is known under the name of yeast. Placed under proper conditions, the joints undergo a further change, and give rise to two or three species of mould.

We have put together these curious facts, believing that they will be novel and interesting to many who have little suspected how much of destructiveness, of use, of ornament, and of nutriment lie hidden in this humble order of plants. But we may properly ask, What is their office and service in the grand economy of creation? Such office they have, and such service they perform, though cast out and trodden under foot of men. "If the tree fall toward the south, or toward the north, in the place where the tree falleth, there it shall be." So saith the Preacher; and the fungologist adds to his discourse what he has observed by studying the fallen tree. Of itself, it would long cumber the ground, and lie all its length a useless log. But the invisible spawn of the fungus draws nutriment out of its dead mass, and begins to grow upon this ligneous tomb, and to thrive upon the decay which it hastens and aggravates. It is life, even though of the lowest order, springing out of death. It is birth and increase coming up from the very mass of decay and diminution. The tree rots into powder, the fungus flourishes and spreads out until it forms a new soil. Floating and flying seeds drop down from the wings of the wind and find a lodgment here, and begin to sprout and bring forth leaves. Companions are added to them from every passing breeze; and, finally, where once the dead tree lay prostrate, a vegetable blank in the midst of green life all around it, up come herbs and plants, and the kindly earth is rid of one great, useless burden, and ready to bear again the leaf and stem, and perhaps the flower and fruit.

AMERICAN FOSSIL FLORAS.

At the meeting of the American Association, 1860, Dr. Newberry gave a sketch of the succession of different floras on the North American continent, remarking that the Devonian and Carboniferous floras had been carefully studied and characterized by the prevalence of cryptogamous plants, as ferns, etc., and that the floras of America during these ages were strikingly like those of Europe of the same epoch. The Permian flora was scarcely known in this country; it was but a continuation of the Carboniferous. He observed that the Triassic and Jurassic floras were characterized by the prevalence of numerous and beautiful Cycadaceous plants which had been studied and beautifully illustrated by European fossil botanists, but had hitherto been very little known in this country. Recently he had procured a large number of fossil plants of this age from New Mexico and elsewhere, which had shown that, as in Europe, the flora of America, during the period of deposition of the New Red Sandstone, was cycadaceous in character and similar to that of Europe. At the commencement of the cretaceous era, however, the flora of the continent was revolutionized, and apparently suddenly, though doubtless gradually. The broad-leaved dicotyledonous plants were introduced, and the vegetation of the continent assumed the general aspect which it has at the present day. Among the cretaceous plants are found species of *Liriodendron* (tulip-tree), *Liquid-amber* (sweet-gum), *Sassafras*, etc., etc.,—gen-

era now living in our forests, of which the first two existed on the continent of Europe during the tertiary ages, but are not now known there. Dr. Newberry concluded by saying that the aspects of nature, as far as vegetation is concerned, on our continent, are of an antique type, and that the plants, as was the case with many of the fishes, were old-fashioned forms. The climate of the United States, as indicated by these plants, had been, through the cretaceous epoch, temperate, and much as now; but during the tertiary it had been slightly warmer than at present, but still temperate, and cooler than the climate of Europe at the same epoch.

NOTES ON THE ARCTIC FLORA.

The following notes on the "Arctic Flora," founded on two voyages to the shores of Davis' Straits, have been presented to the British Association by Mr. Taylor: —

From seventy-two to seventy-four degrees north, on the east or Greenland side, the coast is rocky and precipitous. Along this coast also there are numerous islands, more or less conical in form, which also present precipitous cliffs. The land in the interior consists of a complicated system of ravines and mountain ranges, the former usually occupied by glaciers; between seventy-four degrees and Cape York the surface seems to present an extensive *mer de glace*. The original soil varies in its nature, having often more or less peat on the surface.

The land on the west or American side of the strait presents an extensive plain along the sea border, the mountains in the interior being fewer than on the east side, but apparently higher. This land is also destitute of glaciers, and its sea free from icebergs; any which occur have been drifted from another quarter. In the interior there are mountains, plains, and numerous lakes.

The east side is sooner clear of snow than the west side, just as that border of the strait is soonest clear of ice. On the land the snow first disappears in a zone fifty to one hundred feet above the sea, extending thence upward and downward.

The flora is on the whole rich and varied; about one hundred and fourteen species of plants were collected (a list was given), belonging to twenty-four natural orders, in the proportion of seventy Dicotyledons to thirty-eight Monocotyledons, and in addition three Ferns, two Lycopodiums, and one Equisetum, besides numerous Mosses and Lichens. *Saxifraga oppositifolia* and *Salix herbacea* were the first seen in flower, the former in March, the latter about the end of May; the species of *Ranunculus* and *Papaver nudicaule* are among the latest; *Saxifraga Hirculus* is also late, flowering in the middle of August. *Ranunculus sulphureus* and *Papaver nudicaule* burst through a covering of snow at the time of flowering. On many species the mature fruit is perfectly preserved under the snow during the long winter, and thus different birds find abundance of food in spring; the natives also avail themselves of the same supply. The buds on the peduncle of *Polygonium viviparum* are greedily devoured by the Ptarmigan and Snowflake.

OBSERVATIONS ON THE PLANTS WHICH, BY THEIR GROWTH AND DECOMPOSITION, FORM THE PRINCIPAL PART OF THE IRISH TURF-BOGS.

In a paper on the above subject, read before the British Association by Mr. D. Moore, the author observed that, although much has been written on

the subject, and many able reports made on it, strange to say, no one has yet given any intelligible account of the species of plants which enter principally into the formation of the turf-bogs of Ireland, although so large a portion of the surface of the country is covered with them, and bog-labor constitutes no inconsiderable item of productive economy in Ireland. By far the greatest portion of the bogs in Ireland consists of the kind called red bog, which varies in depth from ten to forty feet, or even more. This variety is the least valuable for fuel, owing to its soft fibrous consistency. It is supposed to have been formed on the sites of extensive ancient lakes, or very wet morasses, which may be inferred from the small quantity of wood found mixed up with it; besides the roots and trunks of trees being mostly found near the edges of the bog, the portions towards the centre being composed of nearly a uniform mass of the *débris* of the list of plants mentioned. It was further stated, that although Sphagnums constitute a large portion of this substance, without the aid of the roots and branches of phanerogamic plants to form a kind of framework to bear up the cryptogamic species, the formation of bog could not go on at nearly so quick a ratio as it does. In the absence of all trustworthy experiments on the growth of bog, the rate of increase could not be well ascertained, but holes out of which turf had been cut had been observed filled up with soft vegetable matter, to the depth of one foot in five years, which if supposed to be ultimately compressed into one-fourth part that bulk, after being solidified, as near an approach as can be made to the rate of increase of bog at the present day might probably be reckoned on. In limestone districts, where the larger species of Chara abound, whose stems and branches are always thickly incrusted with calcareous substances, the deposition of matter takes place faster than it does where those plants are not so common. The *débris* resulting from *Chara hispida* alone, where it grows freely, will soon fill up a shallow pool, so that plants higher in the scale of vegetation can grow on it. According to the report of the commissioners appointed to report on the nature and extent of the Irish bogs, upwards of a million of English acres are covered with red and brown bog, more than two third parts of which are westward of the river Shannon. The variety called black or turbary bog was next considered in detail, which is the most valuable for fuel, owing to the great quantity of woody matter it contains. This variety is supposed to have been formed on the sites of ancient forests, as is evident from the large quantities of prostrate trunks of trees and their roots, frequently *in situ*, which are found in it. The kinds consist chiefly of *Pinus sylvestris*, *Quercus robur*, *Betula alba*, and *Alnus glutinosa*, though large quantities of yew, *Taxus baccata*, and some mountain ash, are also found in particular districts. The roots of the oaks are generally nearest the margins of the bogs, resting on the clay or marl bottoms, while the Scotch firs occur further towards the centre, and rest on several feet of peat, thus showing that a considerable accumulation of that substance must have taken place before they vegetated on it. These roots are frequently found one above the other, where they have grown, which has led some to suppose there have been several consecutive and distinct epochs of growth, and that some species of the trees which formed them are not now natives of Ireland. This hypothesis was not considered correct, but rather, that by the gradual growth of the bog, matter accumulated and covered the first tier of roots, and the seeds of contiguous trees on falling and vegetating above them grew, and formed in their turn another tier, and so on up to the present surface; as a few of the trees of

those ancient forests which once covered so large a portion of Ireland still exist on the Earl of Arran's property at the present time. After the plants which form this variety of bog were enumerated, the kind called mountain bog was next considered, which sometimes accumulates to a great depth on the tops of mountains, at elevations varying from one thousand to two thousand feet. The Sphagnums do not enter so largely into the composition of this kind, but their place is supplied by the gray moss, *Racomitrium lanuginosum*. The conclusions Mr. Moore has come to on this subject are the following, namely, that so far as proofs exist, the same plants which are now forming the bogs of Ireland have done so from the bottom upwards, though probably at different ratios, as drainage has increased, and that all the species are still in existence in Ireland which have ever formed any part of them. These formations he considers to be of a more recent date than the glacial epochs of geologists, with probably a single exception.

NEW VEGETABLE GUM.

A committee of the Society of Arts in London has recently reported on the new gum *pauchonté*, the product of a tree similar to that which produces gutta-percha. This gum is hard and friable at ordinary temperatures, but by the application of heat it becomes pasty and viscous, and when once it is in this state it does not return to its original condition. When boiled in water, it assumes a reddish-brown color, and makes the water a little soapy. Many reägents act upon it precisely as they do upon gutta-percha. The new gum cannot take the place of gutta-percha, but from twenty to thirty per cent. of it can be mixed with gutta-percha without sensibly changing its properties.

ON THE INFLUENCE OF EXTREME COLD ON SEEDS.

Some experiments, more thorough and satisfactory than those of Edwards and Colin, have been made during the present year by Prof. Elié Wartmann, of Geneva, on the influence of extreme cold upon the seeds of plants. Nine varieties of seeds, some of them tropical, were selected. They were placed in hermetically sealed tubes, and submitted to a cold as severe as science can produce. Some remained fifteen days in a mixture of snow and salt; some were plunged into a bath of snow and sulphuric acid. On the fifth of April, they were all sown in pots placed in the open air. They all germinated, and those which had undergone the rigors of frigidity produced plants as robust as those which had not been submitted to this test.

ZOÖLOGY.

ON SERIES IN THE ANIMAL KINGDOM.—BY DAVID F. WEINLAND.

The existence of certain Zoölogical groups, namely, those of Classes, Orders, Families, and Genera, was first noticed by the father of Zoölogy, Aristotle. Two thousand years afterwards, these groups were again brought to light and named by Linnæus. They have since been improved by Cuvier and Baer, and the idea of type has been added. But it was not till lately that the signification, at least of three of them, viz. of Classes, Orders, and Families, was recognized and circumscribed by Agassiz. These ideas will henceforth stand and be acknowledged as founded in nature.

But the question arises, whether there do not exist still other relations and real affinities of animals to each other, which are not included in these groupings, but which have an equal right to be introduced into our zoölogical system.

We think that this is in fact the case; and we shall endeavor to show in the following sketch that there exist throughout the whole animal kingdom affinities of the animals to each other, which we can comprehend under the name of "Series." About twenty years since, a German naturalist, Kaup, spoke of series in the animal kingdom, but, his ideas proving somewhat arbitrary, the subject received less attention than it deserved. Nevertheless, its truth, if rightly understood, has been since recognized by some distinguished naturalists. Oken, for instance, spoke of a scale among Articulata, in which he placed the worms lowest, next the Crustacea, and last the insects; and Agassiz has illustrated this gradation fully in the development of the butterfly, and has added still another among insects proper; starting from the principle that the chewing rank below the sucking insects.

Another order of position has been recognized by Milne Edwards and by Dana among Polypi; another by Leopold von Buch among Cephalopods; another by Dana for Crustacea. We have tried to trace out these gradations also among the higher animals, and the success we have met with, wherever we have had accurate information, has convinced us that such gradations, which might very properly be termed series, really exist throughout the animal kingdom.

Thus, among Mammalia, we have recognized until now two natural series running parallel to each other, a carnivorous and a herbivorous series. The carnivorous begins with the whales, runs through the dolphin, seal, and lutra, to the marten, whence it divides into two branches, one Plantigradous,

the other Digitigradous. The latter of these branches runs through the cat, leopard, and dog, where it ends; the other, that of the plantigradous, runs through Nasua, Procyon (raccoon), bear, to the cynocephalous monkey, and through the higher monkeys to man. In this latter series, we would call the attention of naturalists particularly to the bear, as the intermediate link between carnivorous animals and monkeys. When we consider the mixed animal and vegetable food of the bear, its manner of life, and general habits, its climbing and embracing propensities, — for in the bear we find an arm capable of embracing, as in the monkey, — and when we observe its manner of standing upright on its plantigradous feet, which is evidently connected with the use of the fore legs as arms, there can be no doubt that the bear fills out that gap which seems to exist between carnivorous animals and monkeys. Such is the carnivorous series.

Parallel to this, and analogous to it, runs a herbivorous series; beginning with the Zeuglodons, and running through Sirenoids, Morse, Dinotherium to Anoplotherium. Here it divides into two, the Pachyderms and Ruminants, and thus Owen was right when he said that the Anoplotherium includes the characters of Ruminants and Pachyderms. From Anoplotherium starts on one side the Ruminant series, running through camel, cow, antelope, deer, and on the other side the Pachyderm series, running from Anoplotherium to Palæotherium and Tapir. At this point we have another division into the series of horses, which culminates in our domesticated horse, and the series of hogs, which embraces rhinoceros, elephants, and hogs.

Among Birds, there are at least four series; one starting from the ostriches, and ending with the Gallinaceæ (I would remark, in passing, upon the striking similarity which exists between the ostrich and the young of the domestic fowl); a second beginning with the pelican, and ending with the Gallinula, a wader; a third beginning with the hawks, and ending with the singing-birds; a fourth beginning with Rhamphastos, and ending with the parrot; another beginning with the Buceros, and ending with the swallow and humming-bird.

In Reptiles, there appears to be but one series, — snakes, lizards, and turtles; the snakes, moving by the dorsal column, and having head, neck, trunk, and tail united in one continuous body, are analogous to the whales and the Sirenoids. The lizards, provided with a distinct neck, trunk, and tail, and with legs, are analogous, the lower ones, the Anguiformes, to the seals, the higher to Lutra and Marten. In the turtles, the distinction of parts is carried still further; the head and neck are very free, the trunk, which in lizards assists in locomotion, is scarcely used for this purpose, and the four legs are the locomotory organs. In the class of Batrachia we have again the same series. Cæcilia is snake-like, and wholly analogous to the snakes and to whales. Icthyoids and Salamanders, provided with small or well-developed legs, are wholly analogous to lizards, and the frogs and toads to turtles. In frogs and toads, also, the four legs are the only organs of locomotion, but the neck and head are not as free as in turtles. This goes far to prove that the class of Batrachians ranks lower than that of Reptiles.

ON THE EMBRYOLOGY OF THE SKATE.

At a recent meeting of the Boston Society of Natural History, the president, Professor Wyman, gave an account of some observations which he had made upon the formation of the peculiarly-shaped egg-case of skates.

At a former meeting he had stated that in a single instance he had found one of these cases partially formed in the oviduct, and was struck with the fact that it contained no yolk. Through the kindness of Mr. Green, the Curator of Comparative Anatomy, he had had an opportunity of examining the oviduct of a skate in which an incomplete egg-case existed in each oviduct; two of the horns, and the bundle of threads at their base, and a portion of the body of the case, were already formed, but there were no yolks in the oviduct, and only one *corpus luteum* in the ovary, probably connected with the previous detachment of an ovum. These observations would seem to show that this egg-case is more or less completely formed first, the yolk subsequently introduced and closed in, contrary to the order of things with eggs generally. The materials of the egg-case were detected in the tubules of the gland of this oviduct, and consisted of granules and long slender threads. The case is formed in the central cavity of the gland, and, as it is built up, the formed portions gradually extend into the lower part of the oviduct. The ovulation of skates resembles that of birds rather than of ordinary fishes. In the latter, the eggs are all formed simultaneously, and discharged at once, or nearly so, while in the former, as in birds, one yolk descends in the oviduct at a time, is encased in the covering, and lost before another can go through the same process.

Professor Agassiz said that the communication of the president was of importance, as it bore upon several physiological points now under discussion. He had been shown by the president the egg still in the ovary (where it must have been fecundated), and the shell below prepared to receive it. In this connection, he was reminded of a fact noticed by himself some time since, with reference to those organs upon the side of the skate called claspers, and which are supposed to be used for prehensile purposes. It occurred to him that they might be organs of copulation; and he found that when they were rotated forwards and upwards, an opening in them was brought opposite to the spermatic duct, and he imagined that they could be introduced readily into the female organs, into the oviducts, and reach the glands described, whence the spermatic fluid would pass up. The president's observations rendered this view of the functions of the clasper still more probable. *Plagiostomes* have a very different method of reproduction from other fishes. Like birds, they produce few but large eggs, and these are found to be of various sizes and different degrees of development in the ovary, indicating that several years are required for their maturity, as is the case in turtles. These facts and others serve to confirm the affinities of the sharks and skates, and to separate them from fishes proper. Aristotle does not speak of *Plagiostomes* with fishes, but calls them *Selachians*, and Professor Agassiz follows the ancient naturalist, giving them the same name. If the *Selachians* constitute a natural class, then some of the data of palæontology may be better understood than they now are. Fishes are generally considered to have been the earliest vertebrate animals created; but, in fact, they were not. The earliest were *Ganoids* and *Selachians*.

EMBRYOLOGY OF FISHES.

The development of Fishes is distinguished from that of the scaly Reptiles, the Birds, and Mammals, in that neither *amnion* nor *allantoïs* is formed. In the beginning, that dividing or cleaving of the yolk is perceptible, which we have already spoken of in different classes of invertebrate animals.

When the yolk has again become smooth, the germinal disc appears, and, as it grows, spreads itself over the yolk until it quite surrounds it. After it has thus become a vesicle, or in some fishes even before this period, there arises, in that part of the germ-disc which is first formed, a longitudinal groove as the first commencement of the embryo. Two projecting edges surround this groove and approach each other, whilst at the bottom of the groove the dorsal cord, as the first commencement of the skeleton, is formed. The innermost layer of the germ-membrane (the mucous layer) presents a constriction, and is thus divided into a canal, situated beneath the dorsal cord, and then into a vitelline sac. In some fishes this vitelline sac is included in the ventral cavity with the intestinal canal by the walls of the abdomen, formed from the serous layer; there is thus an internal vitelline sac present in these, and the abdomen of the embryo presents an unusual projection (*Cyprinus*, *Perca*, *Salmo*); in others the abdominal covering is drawn together by constriction like the mucous layer, and the vitelline sac hangs on the outside of the ventral cavity, being attached to it by a short pedicle (*Blennius viviparus*, *Cottus gobio*, *Syngnathus*). In the *Plagiostomes* (sharks and rays), an external vitelline sac is similarly observed, which here, however, has a long pedicle, which in some sharks is beset externally with *villi*. In most of these fishes the umbilico-intestinal duct is continued within the abdomen into a second internal vitelline sac: a blind sac, which occupies a large part of the ventral cavity, and is inserted into the anterior bladder-like portion of the intestinal canal above the commencement of the spiral valve. The lateral walls of the body of the embryo, which are at first smooth, suddenly present on each side five (or six) fissures of equal width. Between these fissures four small streaks are formed as the commencement of the branchial arches. In front of the first fissure, and behind the mouth, arises a wider arch, divided by a groove into two parts. The anterior half of this is changed into the under jaw, and the various bony pieces which unite it with the cranium. From the posterior half arise the horns of the tongue-bone; at the posterior margin of these parts, in bony fishes, the gill-covers and the branchial rays are developed at a later period only, the branchial arches being at first unprotected. The unpaired fins arise at first as a long fold of skin, which surrounds the body, and is much more extensive than the future *pinna dorsalis* and *analis*. All the bony fishes, whose development has been hitherto observed, quit their egg-covers at a very early period, and whilst still imperfectly formed. In the embryos of sharks and rays, the filaments which hang freely from the branchial fissures — productions of the internal leaflets of the gills, reminding us of the external gills of larvæ of Salamanders — are especially deserving of regard. — *Van der Hoeven's Zoölogy.*

NEW FACTS IN EMBRYOLOGY.

At a late meeting of the Boston Society of Natural History, Prof. Agassiz stated that Dr. Augustus Müller had recently published a paper on the Embryology of *Petromyzon* (the Lamprey), presenting facts hardly to be credited if they had not emanated from such authority. In the family of Cyclostome Fishes there have been placed two characteristic genera, viz. *Petromyzon* and *Ammocetes*. From the egg of *Petromyzon* Müller says he has raised *Ammocetes*, and he has likewise seen the latter become a *Petromyzon*. It is now well established that fishes undergo a form of metamorphosis, as

well as insects. Prof. Agassiz had himself, within a few weeks, had an opportunity of studying the embryology of a species of shark (*Acantheus Americanus*). He had found the yolk, not surrounded by an amnios, but resting in the centre of an area vasculosa, and presenting, in its early development, other peculiarities only known to exist in the egg-laying vertebrata. He considered *Plagiostomes* a distinct class of animals from fishes, and he thought it probable that *Cyclostomes* should also be separated as a class. He could not refer to one class animals developed in such different modes. The number of classes into which the animal kingdom is divided — into six by Linnæus, into sixteen by Cuvier, and into twenty-nine by Ehrenberg — shows that anatomical differences are insufficient for a proper determination of classes. He proposed that the general plan of structure be a test for types, and the manner in which this plan is developed the test for classes.

Prof. Agassiz, in alluding to the probability of a fecundation of the egg whilst in the ovary, stated that Dr. Weinland had found, in the viviparous *Zoarces anguillaris*, that the ovarian bag (Graafian vesicle) of the mature eggs was not a simple sac, but a double one; and, further, that this double sac was not continuous over the complete circumference of the egg, but that a disc of considerable size remained uncovered at the upper part, where the spermatozoa might come in contact with the yolk membrane. Dr. Weinland had also found the same condition in the skates and turtles. Prof. Agassiz thought that the same organization would be found in all vertebrata.

FECUNDITY OF CERTAIN FRESH-WATER MOLLUSCS.

At a meeting of the American Academy, May, 1859, Mr. Isaac Lea exhibited some remarkable specimens of Unionidæ, six to eight inches wide. Some of these had the soft parts, and he called attention to two fine specimens of *Margaritana complanata* and *Unio multiplicatus*, both females, with the oviducts fully charged with embryonic shells, ready to be discharged by the parents. There were two important points he wished to be noticed. 1st. The enormous quantity of young in the mass of the outer branchiæ of the *Margaritana* (the branchiæ were 3 × 1¼ × ½ inches), each specimen containing probably several millions of individuals. 2d. That the *Unio multiplicatus* was peculiar in having *both lobes* on *both sides* charged with embryonic shells, containing no doubt several millions of individuals. This species of the *Unio* is the only one Mr. Lea had ever observed furnished with oviducts in all the four lobes of the branchiæ. It is very probable that half a dozen of these *Mollusca* would produce individuals equal in number to the population of the whole United States.

ON THE REPRODUCTION OF PARASITIC ANIMALS.

At a meeting of the Boston Society of Natural History, Dr. D. F. Weinland gave an account of the Reproduction of Parasitic Animals, and explained the phenomena of alternation of generation in the parasitic Trematoda of the freshwater snails. The first generation of this animal exists, in the form of "Distoma," in the intestines or lungs of vertebrata, as a perfect animal with genital organs producing eggs; the next generation exists as a yellow worm in the liver of the snails mentioned above, with or without an intestine, their bodies being filled with the third generation of the animal,

viz. little worms with long tails, — the so-called Cercarians, — which originate in the body of the yellow worm by a kind of budding. In the third generation, these Cercarians are brought forth by the mother, swim for a while free in the water, and then become a kind of pupa, forming a cyst around themselves, and in this state seeming to wait till, by chance, they are swallowed by a vertebrated animal, in which they become in a few days, as is shown by experiment, a perfect Distoma.

Dr. Weinland has found a new species of Cercaria, the first known in this country, in the liver of the *Physa heterostropha*, and he concludes, from further investigations, that this Cercaria belongs as a larva to a blackish-spotted Distoma, which he has found frequently in the lungs of frogs and toads, and once in the intestine of a turtle, and which he proposes to describe under the name of *Distoma atriventre.*

He added that a similar alternation of generation takes place in another order of Helminthes or parasitic worms, viz. the order of Cestoda. The investigations of Kuchenmeister and Siebold have shown that the cysts in the flesh of the hog, causing the condition known under the name of "measly pork," are pupæ of the human tapeworm, and that they develop themselves into the latter when taken into the human intestine; and that the human tapeworm, when eaten by a hog, produces in this animal these cysts. In three instances, in which he had seen tapeworms in Americans, these worms were identical with the *Tænia solium*, the tapeworm of the English and Germans, the same species upon which the experiments of Kuchenmeister were made, — not the *Botriocephalus latus*, the tapeworm of the French and Swiss, which seems to have a different kind of development. He had found a larva of a tapeworm, a so-called Scolen, with two large red spots behind the head, in the intestine of the common alewife (*Alosa Americana*), provided with four large suckers (*acetabula*), but not having an articulated body, nor genital organs. This larva was destined, as he supposed, to become a perfect tapeworm only in the body of another vertebrated animal by which the alewife might be swallowed, — perhaps in a shark. He had found another larva of a tapeworm, the *Tetrarhynchus Morrhuæ*, Rud. (*T. corollatus*, Siebold), in a cyst near the heart of the common codfish. He had found the larva of tapeworms, known under the name of Cysticercus, in the pelvic region of the American hare (*Lepus Americanus*), and in the liver of the rat (*Mus decumanus*). After a careful comparison he found them identical, one with the Cysticercus of the European hare, and the other with that of the European rat; which become, according to the experiments of the same helminthologist, Kuchenmeister, the first, the tapeworm of the dog, and the second that of the cat; a fact likewise noticed by the American hunters.

Dr. Weinland supposed that this Cysticercus of the American hare came from the European dog; the eggs of the tapeworm having been swallowed by the hare, perhaps with vegetable food. In another and new species of tapeworm, the *Tænia punctata*, Weinl., found in the gold-winged woodpecker, he had observed the embryo just hatching. The shell of the egg of this worm has two processes, each terminating in a large ball; the embryo is provided with six spines. Some years ago, Dr. Hein and Dr. Meissner found pupæ of tapeworms in cysts in a land-snail (*Helix pomatia*), and in a beetle (*Tenebrio molitor*), and in the cyst were found six little spines thrown off by the embryo. Thus we have reason to believe that that hatching embryo, with its six spines, penetrates into an insect or a mollusc, forms there a

pupa, loses its spines, and waits in this state till the snail or the insect is swallowed by a vertebrate; for in vertebrata only we find perfect tapeworms. In the case of *Tænia punctata*, we may suppose that the embryo enters an insect, forms there a pupa, which afterwards is eaten with the insect by the woodpecker, and then is developed into a tapeworm. Thus, the intimate relations existing between the woodpecker, its tapeworm, and the insects in which the latter lives as a pupa, and upon which the woodpecker feeds, must be intimately concerned in the preservation of the species of this worm; and if we consider how infinitely small is the chance of a single egg's perfecting its development in that bird, we see why one tapeworm should furnish millions of eggs in a year.

The Psorospermia, discovered first by Johannes Müller, which may be another larval state of a worm, Dr. Weinland has found by thousands attached to the hind part of the eye-bulb of the American haddock (*Gadus aeglefinus*).

To a question proposed by Dr. Gould, "Whence come the parasitic worms of the fœtus in utero?" Dr. Weinland answered, that only two or three such instances are known; and from the fact that he once witnessed an Ascaris penetrating a membrane in such a manner that, after it had traversed it, there was not to be seen any perforation in the membrane (the worm having separated the fibres of the tissue without tearing it), he thought that he could explain the presence of the worms, found in the embryo, by a passage from the abdomen of the mother and through the walls of the womb, and thence into the body of the embryo; a movement which, according to this observation of Ascaris, could be effected without wounding the tissues.

ON THE TAPEWORM.

One of the most valuable contributions recently made in pathology and zoölogy is an essay by Dr. D. F. Moreland, of Boston, entitled "The Tapeworms of Man: their nature, organization, embryonic development, the pathological symptoms they produce, and the remedies which have proved successful in modern practice."

The following extracts from its pages, made by the editors of *Silliman's Journal*, will be found to contain facts of a most curious and interesting character: —

Every butcher is acquainted with the disease in the muscles of the domesticated hog, denominated "measles," and calls the flesh of such a hog "measly pork." It has long been known that those pea-like whitish globules (measles) contain a curious animal, namely, the perfect head and neck of a tapeworm, ending, however, not in the long jointed body of the regular tapeworm, but in a water-bladder. No traces of reproductive organs are to be seen. Such measles are found not only in the hog, but also in other animals, where they are better known under the name of *Hydatids*. For example, they are very often met with in the liver of rats and mice; in the mesentery of the hare; and even, though more rarely, in the muscles of man; and those of the latter have turned out to be of the same species (*Cysticercus Cellulosæ*, Rudolphi) as those found in the hog. All the different species of this sort of hydatids are known in science under the generic name of *Cysticercus*.

Again, other hydatids, varying from the size of a pea to a diameter of several inches, are occasionally found in the lungs, the liver, and other

organs of man, but more frequently in the liver and lungs of our domesticated Ruminants, such as oxen, sheep, and goats. These hydatids are roundish bladders of milky-white color, containing a watery fluid, in which swim many whitish granules; each of these granules is, as a good lens will show, a well-developed head and neck of a *Tænia*, inverted into a little bag. This kind of hydatid, also, has been considered as a distinct genus of intestinal worms, and called *Echinococcus.*

Again, a disease frequently occurs in the brain of sheep, producing vertigo (German, *Dreher*, French, *tournis*). This was ascertained, years ago, to be caused by another sort of hydatid, appearing as a bladder, often of several inches in diameter; and, as in Cysticercus and Echinococcus, filled with a watery fluid. On the outside of these bladders are attached a number (often hundreds) of tapeworm heads, all retractile into the inside of the bladder by inversion like the finger of a glove. This hydatid was considered by zoölogists as a third genus, called *Cœnurus.*

These three genera, *Cysticercus*, *Echinococcus*, and *Cœnurus*, formed until recently an order in the class of intestinal worms, called *Cystica* (bladder worms, or vesicular worms). But we now know that all of this group are merely larvæ of tapeworms, and that the whole order of *Cystica*, being composed of larvæ of *Cestoidea*, must therefore be dropped from our zoölogical system.

This important discovery was made as follows: Ephraim Götze, a German clergyman and naturalist of the last century, had noticed a singular similarity between the heads of some Cysticerci and those of some tapeworms. He had particularly noticed this similarity between the tapeworm of the cat (*Tænia crassicollis*) and the Cysticercus which is found in the liver of the rat and mouse (*Cysticercus fascioluris*). C. T. von Siebold, the most noted helminthologist now living, had observed the same thing, and in 1848 had already alluded to the possibility that all these Cystica might be nothing but undeveloped or larval tapeworms. In his system, however, he still recognized the *Cystica* as a distinct order of Helminths.

In the year 1851, F. Küchenmeister first proved by experiment that a certain hydatid, when brought into a suitable place, is developed into a tapeworm. He fed a dog with the hydatids (*Cysticercus pisiformis*) found in the mesentery of the hare, and on dissecting the dog, after a number of weeks, found these Cysticerci alive in the small intestine. They had, however, lost their tail-bladder, and the neck had begun to form the joints of a true tapeworm, which worm had been long well-known as *Tænia serrata*, and as common in the dog. Now, one discovery followed another. Governments, scientific institutions, and wealthy farmers furnished the money and animals to carry on the experiments on a large scale. Siebold fed a dog with the *Echinococcus* of the ox, and thus raised the *Tænia Echinococcus*, Siebold. It was also found in the same way that the *Cœnurus* from the brain of sheep is the larvæ of another *Tænia* of the dog, *Tænia Cœnurus*, Siebold.

Now the question, whence does man get his tapeworm? was ready to be answered. It had been observed that the hydatids of the hog, commonly called "measles" (in the zoölogical system, *Cysticercus Cellulosæ*), have exactly the same head as the common tapeworm of man (*Tænia Solium*, L.); and after the experiments mentioned above, in relation to the different tapeworms of dogs, a doubt could hardly exist that *Cysticercus Cellulosæ* of the hog was the larvæ of the common human tapeworm (*Tænia Solium*). Küchenmeister, who wished to make sure of the fact, made the experiment upon a criminal who was

soon to be executed, and, as was to be expected, with perfect success. Measles taken from fresh pork, and put into sausages which the criminal ate raw, at certain intervals before his death, were found again, in the post-mortem examination, as tapeworms in his intestine, and in different stages of development, according to the intervals in which the measles had been taken.

Thus it became clear that all hydatids are tapeworm larvæ, which, when swallowed with the animal, or a portion of it, in which they live, by another animal, develop in the intestine of the latter.

Now the opportunity for experiments was again open in another direction. If the tapeworm embryo developed its scolex or head by interior budding, it was likely that those animals having hydatids got them by eating the eggs of the species of tapeworm to which those hydatids belonged. And this has been proved by experiment. Goats fed with eggs of the *Tænia Echinococcus* got the Echinococcus; sheep fed with the eggs of *Tænia Cœnurus* got the Cœnurus in their brain; healthy young hogs fed with the eggs of the human tapeworm got the measles. Küchenmeister, Siebold Van Beneden, Gurlt, Luschka, Wagener, Leuckart, Eschricht, and others, have the merit of tracing this interesting development. From their further investigation, it became moreover evident that the Cœnurus also, with its many heads, originated from *one* embryo, which, enlarging greatly, throws out as buds from its interior, not one, but many scolices; moreover, that the process is also exactly the same in *Echinococcus*, except that in this hydatid the scolices free themselves after a while from the internal walls of the bladder, and thus swim in the fluid contained in the bladder, the latter itself being simply the enlarged embryo.

But the zeal of these investigators did not rest here. If the sheep gets by chance the eggs of the *Tænia Cœnurus* of the dog into its stomach, how do the embryos hatching from those eggs reach a suitable place for their development into hydatids, which place is, in the sheep, the brain? It had been erroneously assumed that they bored with their spines *recta via* from the stomach through all the tissues and organs until they reached the brain. Accordingly, in the hog, the embryos of the Tænia would have to go from the stomach into the muscles; in the rat, into the liver; and in the ox, into the lungs; for it is only in these particular organs that these hydatids are found.

R. Leuckart, however, discovered the way in which the embryos actually reach their destined resting places. On feeding rabbits with the eggs of *Tænia serrata*, he found that, some hours after the feeding, the egg-shells were already dissolved into prismatic granules by the juices of the stomach, and the embryos set free. But on putting the eggs immediately in the intestine (through an artificial opening) they were not hatched. It was clear, therefore, that only the gastric juice could hatch the embryos; and this accounts at once for the strange fact, that the embryo never hatches in the intestine of the animal where the tapeworm itself lives. Moreover, he found that they do not pass from the stomach into the intestine, and hence, as had been supposed, through the bile-ducts into the liver, but that they pierce the blood-vessels, and thus come into the circulation. He even, after a long search, found four perfect embryos in the blood taken from the *vena portæ*. It is by the blood that the embryos of tapeworms are carried to the organs in which they develop into hydatids. It now at once became obvious how easily they reach the muscles, the brain, the lungs, etc. But it is to be supposed that only those which reach the destined organ will develop themselves, while the rest, which are carried to other organs, must perish.

THE COMPOSITION OF ATMOSPHERIC DUST.

The composition of atmospheric dust will always be of two kinds, inorganic and organic, that is to say, mineral particles, and the skeletons of animalcules, or the skeletons and seeds of plants. The mineral particles will of course depend on the nature of the soil and position of the spot whence the dust was derived. It may be swept in from the gravel walks of a garden, from the highroad, or from the busy street. The grinding of vehicles, the wear of busy feet, the disintegration everywhere going on, keep up a constant supply of dust. The smoke of chimney and factory, steamship and railway, blackens the air with coal-dust. If silicious rocks are not a great way off, we shall find abundance of particles of silica, with sharp angles, sometimes transparent, sometimes yellow, and sometimes black. And this silica will occasionally be in so fine a powdered condition, that the granules will look like very minute eggs, for which, indeed, many microscopists have mistaken them. In this doubt we have recourse to chemistry, and its tests assure us that we have silica, not eggs, before us. Besides the silica, we see chalk in great abundance; and, if near a foundry, we shall certainly detect the grains of oxide of iron (rust), and not a little coal-dust. Our houses, our public buildings, and our pavements, are silently being worn away by the wind and weather, and the particles that are thus torn off are carried into the dust-clouds of the air, to settle where the wind listeth and the housemaid neglecteth.

There is one thing which will perhaps be found in every place, and in every pinch of dust, which is not a little surprising. It is starch. No object is more familiar to the microscopist than the grain of starch. It is sometimes oval, sometimes spherical, and varies in size. The addition of a little iodine gives it a blue color, which disappears under the influence of light. There seems to be no difference between the starch grains found in the dust of Egyptian tombs and Roman temples, and that found in the breakfast-parlor of to-day. They both respond to chemical and physical tests in the same way. But there is one curious fact which has been observed by M. Pouchet of Rouen, namely, that in examining the dust of many centuries he has sometimes found the starch grains of a clear blue color; and he asks whether this may not be due to the action of iodine in the air, traces of which, M. Chatin says, always exist in the air. The objection to this explanation is, that if iodine is always present in sufficient quantities to color starch, the grains of starch should often be colored, whereas no one but M. Pouchet has observed colored grains, and he but rarely. M. Pouchet tells us that, amazed at the abundance of starch grains which he found in dust, he set about examining the dust of all ages, and all kinds of localities,—the monuments and buildings of great cities, the tombs of Egyptian monarchs, the palaces of the age of Pharaoh; nay, he even examined some dust which had penetrated the sculls of embalmed animals. In all these places starch was found. But a moment's reflection dispels the marvellousness of this fact. Starch must necessarily abound, because the wheat, barley, rice, potatoes, etc., which form everywhere the staple of man's food, are abundant in starch; the grains are rubbed off, and scattered by the winds in all directions.

So widely are these grains distributed, that a careful examination of our clothes always detects them. Nay, they are constantly found in our hands, though unsuspected until their presence on the glass slide under the micro-

scope calls attention to them. It is only necessary to take a clear glass slide, and press a moistened finger gently on its surface, to bring several starch grains into view. Nay, this will be the case after repeated washing of the hands; but if you wash your hands in a concentrated solution of potash, no grains will then be found on pressing the moistened finger on the glass. This persistent presence of starch on our hands is not astonishing when we consider the enormous amount of starch which must be rubbed from our food and our linen every instant of the day; and when we consider, on the one hand, the specific lightness of these grains, which enables them to be so easily transported by the air, and, on the other hand, the powerful resistance they offer to all the ordinary causes of destruction, one may safely affirm that in every town or village a cloud of starch is always in the air.

And hereby hangs a tale. Starch is a vegetable substance, and, until a very few years ago, it was believed to have no existence in the animal tissues. But the great pathologist Virchow discovered that in various tissues a substance closely resembling starch was formed, which he considered to be a *morbid* product. The discovery made a great sensation, and many were the ingenious theories started to account for the fact. At last it came to be maintained that starch was a normal constituent of animal tissues; and there is no doubt that investigators might easily find starch in every bit of tissue they handled, since their fingers, as we have seen, are plentifully covered with grains. If, however, proper precautions be taken not to touch the tissue with the fingers, nor the glass slide on which it is placed, no starch will be found. It is because of the starch-clouds in our atmosphere that grains are found on our persons and on almost every microscopical preparation.

But are the starch-clouds all that the sunbeam reveals? By no means. Some *animals* will be found there; not always, indeed, nor very numerously, but enough to create astonishment. And these animals are not insects, disporting themselves; they are either dead or in a state of suspended animation. A few skeletons of the infusoria, scales of the wings of moths and butterflies, and fragments of insect-armor, may be reckoned as so much dust; but there is also dust that is alive, or *capable* of living. You want to know what that dust is? It is always to be found in dry gutters on the house-tops, or in dry moss growing on an old wall; and Spallanzani, the admirable naturalist to whom we owe so much, amazed the world with announcing what old Leeuwenhoek had before announced, namely, that these grains of dust, when moistened, suddenly exhibited themselves as highly organized little animals — the Rotifers and Tardigrades. Water is necessary to their activity. When the gutter is dried up, they roll themselves into balls, and patiently await the next shower. If, in this dried condition, the wind sweeps them away with much other dust, they are quite contented; let them be blown into a pond, they will suddenly revive to energetic life; let them be blown into dusty corners, and they will patiently await better times. Such are some of the things found in the dust of a sunbeam. In addition, a few spears of plants are also frequently found. Knowing that many plants are fertilized by the agency of the wind, one would naturally expect to find pollen grains abundant. Indeed, when we consider how rapidly bread, cheese, jam, ink, and the very walls of the room, if damp, are colored with *mould*, which is a plant; when we consider how impossible it is to keep decaying organic substance free from plants

and animalcules, which start into existence as by magic, and in millions, we have no difficulty in accepting the hypothesis of a universal diffusion of germs — eggs or seeds — through the atmosphere. No matter where you place organic substance in decay, if the air, in never so small a quantity, can get at it, mould and animalcules will be produced. Close it in a phial, seal the cork down, take every precaution against admitting more air than is contained between the cork and the surface of the water, and although you may have ascertained that no plants or animalcules, no seeds or eggs, were present when you corked the bottle, in the course of a little while, say three weeks, on opening the bottle, you will find it abundantly peopled. To explain this, and numerous other facts, the hypothesis of a universal diffusion of germs through the air has been adopted; and the known fecundity of plants and animalcules suffices to warrant the belief that millions of millions of germs may be constantly floating through the air. Ehrenburg computes the rate of possible increase of a single infusory, *Paramecium*, at two hundred and sixty-eight millions a month. And it is calculated that the plant named *Bovista gigantum* will produce four thousand millions of cells in one hour. As the *mould* plants are single cells, and as they multiply by spontaneous division, the rapidity with which they multiply is incalculable.

From all this, you see how naturally the idea of universal diffusion of germs has become an accepted fact. If it is a fact, we must feel not a little astonished at finding the dust we examine so very abundant in starch, coal, silica, chalk, rust, hair, scales, and even live animals, and so strangely deficient in this germ-dust. The germs are said to be everywhere; millions upon millions must be diffused through the air; every inch of surface must be crowded with them. Do we find them? We find occasional pollen grains and seeds. But we find no animalcule eggs, and no animals, except the Rotifers and Tardigrades. We find almost everything but eggs. "O," you will perhaps remark, "that is by no means surprising; if they are diffused in such enormous quantities through the air, it stands to reason that they must be excessively minute, otherwise they would darken the air; and, if they are excessively minute, they escape your detective microscope, that's all." Your remark has great plausibility; indeed, it would have overwhelming force, were there not one fatal objection to the assumption on which it proceeds. If the eggs of animalcules *were* so excessively minute as you imagine them to be, there would be no chance of our detecting them. But it happens that the size of the eggs of those animalcules which are known (and of many we are utterly ignorant) is, comparatively speaking, considerable; at any rate, the eggs, both from size and aspect, are perfectly recognizable inside the animalcule; and, if we can distinguish these eggs when the parent is before us, or when we have crushed them out of her body, it will be difficult to suppose that we could not distinguish them among the other objects in a pinch of dust, when a drop of water has been added.

ZOÖLOGICAL SUMMARY.

Domestication of the Canna in England. — The Canna (*Oreas Canna*), a South African ruminant, and largest of the antelope species, approaches the ox in form and weight, multiplies its kind in captivity, grows rapidly, fattens easily, has a fine-grained and juicy flesh, and there is reason to believe that it may be extensively raised for the market. The present stock in England

was imported by Lord Derby, from the Cape, in 1851, since which time the five — three females and two males — have increased, within eight years, to twenty-seven head; of which fifteen belong to the Zoölogical Society of London. With the exception of one female that has sickened, these animals are all perfectly healthy, and the progeny in England is larger and stronger than the parents. They range with other cattle, and receive no extra food or care. The canna, although petulant and active, is familiar and docile in its behavior. It does not breed with the bovine species. One which was killed for the table in 1858, without having been especially fattened, weighed eleven hundred and seventy-five pounds. Its meat was of delicate flavor, and very fine, close texture.

Angora Goat in France. — The acclimation of the Angora goat has now been completely accomplished in France. The goat is now living and at large in the Vosges, Jura, Cevennes, Alps, mountains of Auvergne and Aveynon, and the Black Forest. It also prospers marvellously in Algeria. The Angora goat was introduced there in 1856; the flock consisted of ten individuals, four males and six females; it has so prospered as to consist now of forty-six individuals, eighteen males and twenty-eight females, and none are at all degenerated from the original stock; the silky hair has lost nothing of its lustre, and affords fine velvets, every way comparable with the silk velvets, and even superior to them, as it does not mat with pressure or friction. M. Bernis, veterinary of the army in Africa, to whom this flock has been intrusted, proposes to produce a mixed breed between the goat of the country and some of the females of the Angora (which are in excess in the flock), and so establish a new variety. The trial has already been made in France, and a mixed breed obtained of very rustic appearance, with hair inferior in quality to that of the pure Angora.

Acclimation of the Lama in France. — The Acclimation Society of the zone of the northeast of France reports a very interesting experiment in the domestication of the lama in the mountains of the Vosges. The lama has been used on a farm, where he has been in the habit of carrying loads of sixty to seventy pounds. He can do the work of a small donkey. He feeds on green or dried grass. He needs no shoeing, which is a great advantage in the Vosges, where the roads are often covered with ice and snow, on which he is as sure-footed as a dog. The expense of keeping him is about equal to that of keeping three sheep. When the ground is covered with snow he eats about ten pounds of hay per day. He seems to endure the cold of winter as well as the heat of summer, and in the mountainous regions of France promises to be of much value.

Birds forming Guano. — M. Raymonde, who was recently sent to the Chincha Islands by the Peruvian Government to report on the existing quantity of guano, makes the following statements: The deposit evidently belongs to the present epoch of the earth's history, and ten species of birds are enumerated as the originators of the guano. These species do not all live constantly on the islands, but some appear only at the breeding season. The pelicans do not appear to produce much guano, as they almost exclusively inhabit the cliffs, and their excrement falls into the ocean. Some of the birds hollow out nests in the guano, and are unable to fly. The birds which produce the largest quantity of guano are the Puffinarias, their number being almost incredible.

Parasites upon Flies. — At a meeting of the Boston Society of Natural History, Professor Wyman remarked that it had probably been frequently

noticed by members of the Society, that the common housefly may be frequently seen hanging dead from the ceiling, or attached to any surface on which it may be lying, by a filamentous white substance; and that a white powder, in greater or less quantity, is frequently seen dotted over the neighboring surface. On examining this substance, he had found the insect to have fallen a victim to a parasitic plant growing upon its surface. The white powder proved to be the spores of the parasite. The whole interior of the fly was found to be filled with a similar plant, and probably, from the different way in which it develops itself, of a different species from that on the surface. The internal parasite starts from a spore, and grows by elongation from one or both sides of a sphere, this latter remaining in the middle or at one end. Prof. Wyman exhibited magnified drawings of these parasites, as they appear under the microscope, in their various stages of development.

On a Cause of Death in Elephants. — At a recent meeting of the Boston Society of Natural History, Prof. Wyman stated that he had been informed by the Rev. Mr. Walker, of the Gaboon (West Africa) Mission, that elephants in that vicinity were frequently swamped and smothered in mud-holes. He regarded the fact as interesting, as showing at the present epoch causes of death similar to those which probably existed in the time of the mastodon, several of which were found together in New Jersey, and were supposed to have been mired in the same locality.

Hen's teeth have been numbered with the Greek kalends, but M. Geoffroy Saint-Hilaire discovered in 1806 that fetal birds have rudiments of teeth, and M. Blanchard, an assistant in the Museum of Natural History at Paris, now announces that some birds have regular systems of teeth; the number of teeth being unequal.

Peculiarities of the Nervous System. — According to Dr. Pfluger, the effect of galvanizing a certain portion of the spinal cord, or the grand sympathetic nerves, is to put a stop to the peristaltic movements of the small intestines. On galvanizing one end of the grand sympathetic, peristaltic movement is arrested throughout the entire length of the small intestines; and thus the result is analogous to that stoppage of the action of the heart which takes place upon galvanizing the pneumogastric. As in the case of the heart, also, the arrestment of movement is rapidly brought about, — rapidly, but after a perceptible interval, — and the state of the muscle is one of relaxation. As in the case of the heart, also, the normal contractions begin again a short time after the current has ceased to pass, if this current has not been passed for too long a time. Dr. P. has also ascertained that the peristaltic movements of the small intestines are not arrested by galvanizing the lesser sympathetic nerves, and that the peristaltic movements of the large intestines are not affected by galvanizing either the large or small sympathetics.

Muscle-forgetfulness. — Baron Heurteloup is the author of a new term, *myolethe*, which may be translated muscle-forgetfulness. The muscular system, being placed under the influence of the cerebro-spinal apparatus, in normal conditions is managed by it. But any strong passion may so occupy the brain that it forgets to continue its action upon the muscle. He says that when we open the mouth, while listening with great attention, it is not, as some of the transcendental physiologists have declared, to open the eustachian tube as a new conduit for the sound, but merely because the under jaw falls; and the under jaw falls because the brain is so much preoccupied that it forgets to hold it up. In the same way, he explains the powerlessness which seizes upon people at any terror, as on the brink of a precipice,

and a great number of similar phenomena. This, too, gives a good explanation of such phenomena as stuttering, and is the key to many chronic diseases.

Conditions of Insanity. — M. Moreau, physician of the Bicêtre, Paris, states in a recent work "that the organic conditions most favorable for the development of the faculties are those which give origin to delirium. Transcendental capacities, or intellectual aptitudes, derive their origin from an extra-physiological condition of the organs of thought, and from this point of view we may consider genius as a neurosis. The axiom of 'a sane mind in a sane body' is false. The deterioration of the physical man is a condition of the perfection of the moral man. The human intelligence is never nearer to its fall than when it is elevated to its highest grandeur. The causes of its fall are also the causes of its grandeur." Again he asserts: "Most individuals endowed with a superior intellect, or even merely placed above the common level of intelligence, reckon among their ancestors and members of their family, lunatics," etc.

M. Meyer, of the insane hospital of Hamburg, has also recently published the results of a long series of observations upon insane patients, in relation to the heat of the body, and the theory of insanity which these observations go to establish. The leading ideas of M. Meyer are briefly as follows: —

All mental disease is accompanied by some corresponding abnormal physical condition. All mental diseases fall into two great classes. In the one the mental action exhibits a state of the intellect below the normal intelligence, — there is evident weakness or confusion of mind. This diseased condition is idiopathic, — comes from the brain. If, in case of any patient of this class, there appears a state of excitement, this excitement indicates at once fever.

In patients of the second great class, the mental strength is not below the normal standard, but the intellectual activity is wrong in direction. The insanity here is "sympathetic or reflected," that is, it does not arise from a diseased brain, but the cause is to be sought in some other organ or part of the body, — the organs of generation, the digestive organs, etc.

While assistant physician in the Insane Department of the Charité at Berlin, Dr. Meyer made the observations above spoken of, in relation to the degree of heat of the bodies of several of his patients. For this purpose he had delicate thermometers constructed, some to be used in the mouth, others *in ano.* The tables of observation show with remarkable uniformity how a change of temperature precedes (or at all events attends) such changes in the mental condition of the patients as belong to one or the other of his two great classes.

Effects of Drunkenness on the Offspring. — At a recent meeting of the Academy of Sciences, Paris, M. Démeaux read a paper exhibiting, in a very striking manner, the very great proclivity to disease incident to children whose fathers are intoxicated at the moment of fecundation. Paralysis, epilepsy, insanity, hysteria, and a long, sad catalogue of disorders of the nervous system, have been classed among the maladies so communicable to children. Moral debility and intellectual obliquity are also said to be not seldom communicated in a similar way.

Antidote for Strychnia. — About a year ago, Dr. Vella, an Italian chemist, announced the discovery of a remedy for tetanus and an antidote to strychnine, in the shape of curarina (*curare*), an alkaloid obtained from the *Lasiostoma curare,* or woorare-tree of South America, and by far the most subtle and

powerful of known poisons. This alleged discovery was received with considerable scepticism, but Vella, who entered immediately upon a series of thorough experiments, now demonstrates, in a paper communicated to the French Academy of Sciences, the truth of his assertion. A quantity of strychnine and an equal amount of curarina, either of which would suffice to produce instantaneous death if administered separately, when given to animals, leads to no dangerous results.

Influence of Cod-Liver Oil and Cocoa-Nut Oil on the Blood. — Dr. T. Thompson, in a paper read before the Royal Society, states that he found that during the administration of cod-liver oil to phthisical patients their blood grew richer in red corpuscles. The use of almond oil and of olive oil was not followed by any remedial effect; but from cocoa-nut oil results were obtained almost as decided as from the oil of the liver of the cod. The oil in question was a pure cocoa oleine, obtained by pressure from crude cocoa-nut oil, as expressed in Ceylon and the Malabar Coast, from the dried cocoa-nut kernel, and refined by treating with an alkali, and then repeatedly washed with distilled water.

Phosphorus in the Animal Economy. — According to the results obtained by M. Mège-Mouriès, organic phosphorus is, not only in the grain of the serials, but also in the egg of animals, the initiative power and the first aliment of the forming embryo. According to this chemist, also, the special group of fatty substances with which this phosphorus is combined in molecules is the special nutriment of the nervous apparatus; hence the acknowledged importance of reducing the amount of phosphorus in medicines to be given to persons under certain nervous conditions. Again, M. Boutigny has proposed the employment of phosphate of lime in lymphatic affections, and has compounded an anti-limphatic wine, which contains phosphate of lime in solution. M. Baud now proposes the employment of fatty phosphates extracted from the spinal marrow of the herbivorous mammals for the restoration of the nerves in all cases of nervous weakness.

Ventilation and Health. — In a recent lecture before the Royal Institution, on the relations of town architecture to public health, Dr. Drewitt stated that close bed-room air was an efficient cause of scrofula and consumption. Thirteen contagious diseases producible at will were enumerated; and the lecturer stated his belief that in time epidemic diseases will be made subject to human control; and that the surest mode of protecting the dwellings of the rich was to cleanse and ventilate the dwellings of the poor.

On the Poison Apparatus of the Rattlesnake. — At a recent meeting of the Boston Society of Natural History, Professor Wyman gave an account of some dissections which he had recently made of the poison apparatus of the rattlesnake.

He had not found the connection of the duct and the poison gland to correspond with the descriptions usually given. The duct proper does not reach the opening at the base of the tooth, but ends at a short distance from it. The communication beyond this is made by means of the sheath of the tooth, which is too loose to prevent the poison from escaping around the exterior of the tooth instead of entering this canal, were it not for the circumstance that, as the tooth is protruded, the sheath is crowded back, and thus made to fit tightly the circumference.

He had seen a rattlesnake, when held in such a manner as to prevent its striking, discharge the poison in a simple jet to the distance of several inches. He also mentioned the habit which the rattlesnake is known to

have of living in company with other animals. While recently in Florida, he had found two large rattlesnakes and an opossum living in the same nest with the wood rat.

Life at Great Depths in the Ocean. — Capt. McClintock, in a recent survey of a submarine telegraph route between the Faroe Islands and Greenland, states, in his report, that during their soundings they brought up from the depth of 1,260 fathoms (7,560 feet) a living star-fish, which had become entangled with the lower portions of the line, which had laid upon the bottom. This fact is particularly interesting as bearing upon the question of the existence of animal life at great depths in the ocean.

Application of Sugar when Lime has entered the Eye. — The *Indicateur de Mayence*, in relation to cases of workmen becoming blinded by the action of lime which has entered the eye, recommends, as a well-approved application in the case of such accidents, a strong solution of sugar, which is to be inserted drop by drop under the eyelids. This application can usually be immediately obtained, and completely prevents the caustic action of the lime. — *Journal de Chimie Med.*

On the Capacity of the Lungs. — Dr. Hutchinson, of England, in a recently published work on the vocal organs, asserts that the capacity of the lungs bears a uniform relation to the height of the individual, this conclusion being based upon experiments made upon 1920 male subjects. The same authority asserts that the capacity of the lungs increases eight cubic inches for every inch above five feet. From fifteen to thirty-five the vital capacity increases with the bodily development, and diminishes from thirty-five to sixty-five, at the rate of about one cubic inch per annum.

ON THE EFFECTS OF ARSENIC ON LARVÆ.

At a recent meeting of the Boston Society of Natural History, Mr. F. H. Storer read the following paper on the power possessed by the larvæ of various common flies of consuming, without apparent injury to themselves, the flesh of animals which have died from the effects of arsenic: —

Larvæ were first observed upon the liver of a subject in whose stomach he had previously detected the presence of arsenic; this liver was found on analysis to be saturated with arsenic. In order to determine if the larvæ were actually nourished by such poisonous flesh, the bodies of several rats killed by arsenious acid were exposed to the flies; in forty-eight hours they were completely fly-blown, and in a week all the flesh had been consumed by the larvæ; after this they changed into chrysalids. These chrysalids on analysis yielded metallic arsenic. It might be supposed that the arsenic thus obtained had been attracted mechanically to the external surface of the larvæ, and had not been swallowed, especially as the denuded bones were covered with a white powder resembling arsenic; however this may be, the larvæ must either instinctively reject the poison, or it is excreted by them after ingestion. A number of these chrysalids were kept, in order to ascertain if they would undergo metamorphosis, and, if so, whether the perfect insects would be healthy and vigorous. Some were kept two months, at the end of which time they were accidentally lost, undergoing no change, remaining however in a perfect state of preservation and full of pulp; a number of small flies, apparently not ichneumons, which gained access to them, died almost immediately, as was supposed from having fed upon them; the empty shells of other chrysalids found about the room showed

that some had been metamorphosed, as none but the arsenically-fed larvæ had been admitted to the apartment. Experiments made to determine how large a quantity of arsenic might be contained in flesh without rendering it unfit for the food of these larvæ were not very satisfactory, from the hardening of the tissue by solutions of this substance preventing the deposition of the eggs; eggs developed in such tissue bring forth living worms, which in his experiments died in six or eight hours. The adult flies perished in great numbers, while depositing the eggs upon the poisoned flesh. Jaeger (quoted by Orfila, *Toxicologie*, i. 379) alludes to the fact that larvæ of flies live a little longer than the perfect insects when arsenious acid is introduced into the digestive organs or applied to their external soft parts. Under favorable moist conditions, the larvæ lived three or four days, and were evidently nearly ready to pass into the chrysalid state. Experiments with arsenic acid, used however in too concentrated a state, also showed that there is a limit to the amount of arsenic which these larvæ can support.

He was inclined to believe that they can eat with impunity any flesh into which arsenic has been carried by vital processes, from the fact of their being found upon the arsenicated liver, an organ capable of absorbing a very large quantity of this poison; anatomical preparations, injected thoroughly with arsenic acid, have been found completely riddled and alive with larvæ.

This matter is important to chemists occupied in judicial investigations, who should not infer that a fly-blown organ can contain no arsenic; though, if flies die almost immediately after alighting on a suspected substance, arsenic is probably present, and should be specially sought for. These facts are also interesting as showing the great differences which exist in animals in their several conditions of metamorphosis, and as indicating the caution with which the results of experiments on one species should be received as applying to other species. The popular belief that a body, dead from the effects of arsenic, must of necessity be preserved from decay for an indefinite length of time, is unquestionably an error; in many cases of murder or suicide, where a great amount of the poison is administered, portions of or even the whole body may be preserved for a long time; but the few grains which it is admitted are enough to cause death cannot preserve from decay so large a mass as a human body. That a small, though fatal, dose will not prevent decomposition, is well known to all who have ever had poisoned rats die in the walls of their houses.

Dr. Cabot made a statement respecting the ravages of the larvæ of *Dermestes* and *Anthreni* in specimens of birds supposed to be sufficiently protected; the former, he said, attack the skin, the latter the legs and bill. Specimens dipped in a very strong solution of corrosive sublimate, and in a saturated solution of arsenious acid in hot water, were attacked by these larvæ; but specimens dipped into a tincture of strychnine were not touched by them. Of the first two poisons, arsenic is the best; in specimens preserved by the latter the skin was not touched, the larvæ boring in through the legs.

Dr. C. T. Jackson, in relation to the preservation of animal tissues by arsenic, mentioned a case in which the stomach, carefully washed, had at first assumed a yellowish tint, becoming soft, with an odor of ammonia, but none of sulphuretted hydrogen, then changing into a pasty mass of a custard yellow, and finally of the magnificent red of the sulphuret of arsenic, the sulphur having been obtained from the decomposition of the tissues. In another case, where the amount of the poison was greater, the abdominal organs were perfectly preserved, and the walls shrivelled.

POISONING BY LOOKING-GLASSES.

Careful observation is beginning to reveal various sources from which injury to the health may arise in quarters heretofore unsuspected. The remarks upon the injurious effects of arsenical pigments have led to the inquiry whether no other injurious matters have been introduced by the luxuries of civilization into our atmospheres.

Mirrors are coated with tinfoil amalgamated with mercury; this mercury gradually evaporates into the atmosphere of the room, and must be received (in infinitesimal quantities) into the system, and, at least, gives ground to inquire what effects may arise from it. This, at least, we know, that the workmen who are engaged in the manufacture of mirrors suffer severely from the effects of the mercury.

Fortunately, the day of quicksilver mirrors appears to be passing away. The superiority of mirrors coated with pure silver, by Liebig's process, appears to be undoubted. Metallic silver is first precipitated upon them,— a coat of $\frac{1}{16,000}$ of a millimeter ($\frac{1}{400,000}$ of an inch) is sufficient. Metallic copper is precipitated on this to strengthen it, and varnish is applied to preserve the copper from oxidation. These mirrors cost no more than those made in the ordinary way, and are said to be far more beautiful. They reflect twenty per cent. more light, and give the objects reflected a warm tone, very different from the pale and cold tone of quicksilver mirrors. A prejudice was excited against them in consequence of some made in London and Paris which did not stand well; but a manufactory at Doos, under the direction of a pupil of Liebig, has produced excellent mirrors, which, after a period of three years, did not exhibit the least deterioration. More particular information will be found in Dingler's *Polytechnic Journal*, Bd. CLVII. § 205. — *Communicated by M. Carey Lea.*

ATTITUDES OF THE DEAD.

It appears that during the recent battles in Italy, some of the French physicians were directed by their superior medical officers, in addition to their more immediate duties to the living, to study the physiological mechanism, if one may so speak, of death itself, as it occurred in the battle-field; that is to say, the physiognomy, positions, and attitudes incidental to death from the arms of war, during, or as soon as possible after, the conflict. Thus the surgeon passed from his operating ambulance to view the fallen. Is not this an intensification of the moral sublime; a unique study, original, French; more than tragedians ever conceived?

Thus, Dr. Armand, physician-major of the first class, chief of the ambulance of the head-quarters of the fourth corps of the French army of Italy, relates from personal observation some interesting particulars concerning the aspects and attitudes of the slain in the battle-fields of the Crimea and of Italy,—a condensed translation or sketch of which (from *Gaz. Hebdom. de Méd.* Sep. 16, 1859) will be subjoined, as worthy of consideration, psychically, physiologically, and traumatically.

During the day of the battle of Magenta, including the night, eight hundred wounded Frenchmen and Austrians underwent capital or minor operations and dressings at the ambulance of Dr. Armand. With his two assistants, he had completed his work by the dawn of the following day,

[illegible] Magenta, and the attitudes [illegible] of the dead preserved, as nearly [illegible] when the messengers [illegible] from life to death [illegible] the head generally lay [illegible] a position which the death- [illegible] part, their weapons still [illegible]

[illegible] attendant upon wounds of the [illegible] dangerously hurt, [illegible] instantaneously, or by surprise. [illegible] the head by a ball, [illegible] Dr. Lambert. The ball had per- [illegible] nevertheless, the patient's [illegible] lay down, having his [illegible] his knapsack against [illegible] his pipe still in his mouth. [illegible] Dr. Armand details a simi- [illegible] Lambert. Dr. Armand's assist- [illegible] smoking on for a dozen of [illegible] his pipe for the last [illegible] his mouth. These cases are, there- [illegible]

[illegible] death-wounds in the heart [illegible] are killed by injury of the [illegible] may allow an atti- [illegible] among others, a Zouave [illegible] or doubled upon his [illegible] face full of energy, as [illegible] than that of a lion.

[illegible] hæmorrhage from a ball [illegible] had been of some dura- [illegible] presented the attitude [illegible] the right, his face and [illegible] hands joined together, with the [illegible] the attitude of prayer. [illegible] quite extensively among [illegible] in the campaign in the [illegible]

[illegible] or less prolonged, the [illegible] through; the face of [illegible] hands and forearms crossed [illegible] itself, and resting on [illegible]

[illegible] hussar killed (as was his [illegible] the right side, having the [illegible] horseman when charging. [illegible] pierced with a ball; his [illegible] died simultaneously. [illegible] Armand relates a parallel [illegible]

At Melegano, several French soldiers while charging bayonet fell, mortally wounded with grape-shot; their faces rested on the ground and their bayonets pointed in advance.

At Magenta, among the slain strewed upon the battle-ground, several Austrian officers were recognized of distinguished physiognomy, dressed with the utmost care and propriety in glossy gloves; one might say that they had affectedly made their toilet in anticipation of death. Their fine blond heads of hair and regular features, for the most part different from the common soldiers, had the expression of bravery and resignation.

Next to such a vast panorama of death, the dead-house of the Charity Hospital of New Orleans, during a great epidemic of yellow fever, may claim a place. The physiognomy of the yellow-fever corpse is usually sad, sullen, and perturbed; the countenance dark, mottled, yellow, livid, stained with blood and black vomit, and swollen; the eyes prominent and bloodshotten and yellow. The veins of the face and of the whole body often become distended; the whole expression is less calm and placid than in most other corpses, especially such as have died of hæmorrhages. — *Dr. B. Dowler in N. O. Medical and Surgical Journal.*

STATISTICS OF CONSUMPTION.

At a recent meeting of the American Geographical Society, New York City, an elaborate paper was presented by Dr. H. B. Millard, "On the Facts and Statistics of Consumption throughout the World." Some of the points of interest embodied in this communication are as follows: —

It has been estimated that about one sixth of all the deaths among the human race occur from consumption. In New York city it destroys one third more lives than all the other diseases of the respiratory organs, such as bronchitis, congestion and inflammation of the lungs, catarrh and influenza, whooping-cough, asthma, etc. No climate is exempt from its sway, but it exercises its remorseless rule in the frosty climes of the north, in the scorching heats of Africa, and in the more genial atmosphere of the temperate zones. In using the word "consumption," the speaker said he referred to that variety of phthisis characterized by a deposition of tubercles in the respiratory organs. Dr. Caspar, in 1847, from a table of 60,000 deaths occurring from various diseases, within twenty or thirty years, found that the ratio of deaths by consumption to deaths from other diseases was as 1 to 5.7. He (the speaker) had found, from a table he had lately constructed, that of 2,771,728 deaths from all diseases, between 1804 and 1860, 483,583 deaths, or 1 in 5.7, were caused by consumption. These deaths occurred in almost every variety of climate. There are, however, some countries in which consumption is entirely unknown. There has been no material increase or diminution of the disease. Statistics of the city of London, kept for two hundred and thirty years, show that from 1629 to 1740 it caused 6.6 part of all the deaths, while from 1740 to 1830 it caused 4.6 part, or nearly one third as many more. Since 1830, however, the deaths have seldom exceeded one sixth part of the whole. In New York, from 1804 to 1820, the deaths by consumption were one in 4.2; from 1820 to 1836, 1 in 5.4; from 1835 to 1850, 1 in 6.5; and from 1848 to 1859, 1 in 8.46. There is no doubt that it has steadily declined since 1805. In Boston, from 1810 to 1818, the deaths by consumption were about 1 in 7. Since then there has been a gradual decrease till 1845, when it caused about 1 death in 6.5. While consumption prevails here to such an alarming extent,

in England, where a more equable climate exists, the proportion of deaths from this disease is much higher than in America. This might, however, be owing to the humidity of the atmosphere there. Mere temperature, or the difference of a few degrees of latitude, has little to do with its prevalence. In New York city, which has a mean annual temperature of 50°, the deaths are 1 in 8.46, while in Charleston, which is situated 8° further south, and has a mean annual temperature of 64°, they are 1 to 6.7. In Philadelphia, with a mean temperature of nearly 54°, the deaths by consumption are 1 in 8.9. In Providence, with a temperature the same as New York, the proportion is 1 to 6. In Chicago it is 1 to 10. In New Orleans, which has a mean temperature of 67°, the proportion in 1850 was 1 to 11.7. In Memphis, in 1859, it was 1 to 11.3. And in Brooklyn, from 1848 to 1859, it was 1 to 8.11. In the United States army there are about thirteen cases of consumption to every thousand men. The greatest number of cases occur on those posts located between 26° and 35° of longitude, in Alabama, Florida, and Mississippi, including the cities of Charleston and New Orleans, which are characterized by high temperature and excessive moisture. The stations in Texas and California show the smallest proportion of deaths from consumption. Probably the smallest proportion of cases anywhere in the United States is in New Mexico, where the deaths are only about 1.3 in every thousand men. High elevation, cold, equable climate, are not calculated to the large development of consumption. The regions of the high latitudes enjoy almost entire immunity from the disease, and in Iceland and among the Esquimaux it is rarely if ever known to occur. It is also a rare disease in Upper Russia and Western Siberia. In Alexandria, situated in the thirty-first degree of latitude, with an atmosphere saturated with saline vapor, consumption is almost wholly unknown; and in Teheran, Persia, situated in latitude 35°, with an elevated position and rarefied air, it is very rare. The medical statistics of the British army afford much valuable information in regard to the prevalence of the disease in different parts of the world, and give a correct impression in relation to the influence of certain varieties of climate. From these we find that in the United Kingdom 5.5 men in a thousand were attacked by consumption. In the West Indies, between the tenth and nineteenth degrees north latitude, there were twelve in a thousand. These returns show how erroneous are the views generally entertained in regard to the influence of the climate of the West Indies, or of a warm climate, *per se*, in arresting the development of consumption. In two of the stations of the Mediterranean, namely, Gibraltar and Malta, long noted as salutary retreats for consumptive patients, it is actually more prevalent and fatal than in Canada and Newfoundland, with their long, cold winters and vicissitudes of climate. In Canada 6.5 per 1000 men are attacked, and 3.8 die of the disease. In Gibraltar 7 are attacked, and in Malta 6.7. In Bermuda, with a great uniformity of climate, 8 per 1000 men are attacked, and 5.1 die, while in Newfoundland the deaths are only 4 per 1000. While on the one hand, therefore, consumption is rare or unknown in those countries situated in high latitudes, we find that it frequently exists in its minimum among those living in tropical countries. In all India, out of ten regiments, the aggregate strength of which was nearly 15,000 men, during a period of fourteen years, only forty-three were attacked.

Madeira, between the thirty-second and thirty-third degrees of north latitude, with its balmy atmosphere, perpetually summer temperature, the thermometer showing a variation only of 10°, and the mean annual temperature

being 65°, seems, of all the countries in the world, best fitted for the mitigation and arrest of consumptive conditions. Patients who come here live three or four years longer than the ordinary duration of the disease in England, and large numbers have resided in the island in perfect health, while their brothers and sisters have fallen victims to the disease at home. Havre, situated near the sea, with a free circulation of air, is nearly exempt from the disease. At Rome about one twentieth, and at Naples one eighth of the deaths occur from consumption.

The theory that the sea sometimes acts as a preventive or palliative of consumption is confirmed by statistics. Out of an aggregate English naval force of 12,942, in the Bay of Bengal, in 1812, 39 were attacked and 16 died of consumption. In an aggregate military force of 14,590, on the island of Ceylon, in the same latitude, 78—just double the number—were attacked, and 51 died. From 1830 to 1836, of an effective total of 159,770 British sailors, stationed in every part of the British dominions, from the Cape of Good Hope to North America, the deaths by consumption were 1.7 per thousand men. In the British army the number of deaths per thousand by consumption is 4.09.

Dr. Caspar, from tables kept at Berlin, shows that the difference in mortality from consumption in various winters has no connection with the difference in temperature, in the coldest and warmest weather the mortality being the same. In a table of 212,407 deaths from consumption in the principal cities of the world, the deaths were, in the spring, 61,945; winter, 55,309; autumn, 45,956.

Consumption is not necessarily more prevalent in large than in small cities, though the rural districts are less liable to its development.

Consumption is a rare disease among African negroes, but the predisposition is increased when they leave home.

The proportion of deaths among gentry and professional men is 16, among tradesmen 28, and among laboring men 30 per cent. Among pressmen in printing offices 31 per cent. die of consumption, and of those confined in an unvarying position 71 per cent.

From the various facts presented, the speaker deduced the following conclusions:—

1. That climate is the most powerful agent in modifying and controlling its prevalence.

2. That there are certain varieties of climate inimical to the development of consumption, and of these the most unfavorable are, first, those characterized by extreme and varying cold; second, climates characterized by a cool, dry atmosphere; third, those which have a very high temperature with but a moderate amount of moisture.

3. That those climates most favorable to consumption are those which have a high temperature and moist atmosphere, and those which are characterized by great variations in the daily temperature. Humidity seems most favorable and dryness most unfavorable to consumption.

4. That the liability is increased by insufficient exercise and confined air.

5. That it is more prevalent among females than males; on land than on the sea; and that the period of its greatest mortality is between the ages of twenty and thirty.

VITAL STATISTICS OF GREAT BRITAIN.

According to the report of the British Register General for 1859, it is estimated that the population of great Britain, — England, Ireland, Scotland, and Wales, — in the middle of 1858, was 22,626,334, and the excess of births over deaths in the year was 246,488. The number of children born alive was 959,676; 351,346 persons were married, and 513,188 died; so that on an average upon every day in the year 2080 children were born, 962 persons married, and 1405 died, leaving a gain of 675 as the result of the day. Rather more than twice as many are born in a year as are married. To 1000 persons living in the two countries, the births in the year were 34 in Great Britain, 27 in France, — a very striking difference. The deaths, 23 in Great Britain, 24 in France. Persons married, 15.5 in Great Britain, 16.9 in France, — a very near equality.

In England and Wales, to every 1000 girls, 1045 boys were born, and 102 males died to every 100 females; but there are more females than males living in England, and out of equal numbers living, 105 males died to every 100 females, the average in twenty-one years being 107. The births are always most numerous in the first half of the year. There were 43,305 children born out of wedlock in the year, or one in every fifteen of all the children born alive. The proportion of boys among the illegitimate births is larger than among the legitimate by about 2 in every 100. The marriages of minors increase. The proportion of minors in 10,000 persons marrying increased from 885 in 1843 to 1212 in 1858. The marriages in 1858 were less than the average. The mortality was high. The number of merchant seamen at sea is calculated at 177,832, and 3486 deaths at sea among this class are reported for the year.

STATISTICS OF SUICIDE.

A work on suicide, recently published by a Frenchman, M. Lisle, states that in France, from 1836 to 1852, inclusive, there were 52,126 suicides, or a mean of 3066 a year. Before 1836 the proportion was 1 suicide to every 17,693 inhabitants. In 1836 it was 1 for 14,207, and in 1852 it had risen to 1 for 9340. In 1838 and 1839 England had 1 suicide for every 15,900 inhabitants; France 1 for every 12,489. Between London and Paris, for the same years, the difference is yet more remarkable, the figures being, for London, 1 in 8250, and for Paris 1 in 2221. The north of France is the most prolific in suicides; nearly half of the whole number belongs to the north, which has increased its own ratio by one-third. The north has 1 in 6483, the east 1 in 13,855, the south 1 in 20,457. The department of the Seine, which includes Paris, has risen with frightful rapidity; but Paris and Marseilles, and all large centres, are the foci of suicides to a very striking extent. Russia stands the lowest of European states in the scale, her suicides being only 1 in 49,182, while Prussia has 1 in 14,404, Austria 1 in 20,900, New York 1 in 7797, Boston 1 in 12,500, Baltimore 1 in 13,650, and Philadelphia 1 in 11,873. The author maintains that suicide is not always a sign of mental alienation, but, like every other human movement, obeys fixed laws, and that hence, year by year, it can be confidently predicted how many out of a certain population will commit suicide. The opinion is expressed that climate has little to do with the matter, and the author says that in latitude from forty-two degrees to fifty-four degrees the proportion is 1 in 38,882; from fifty-

four degrees to sixty-four degrees, 1 in 56,577. Yet the last figures include Moscow and St. Petersburg, and represent a much more rigorous, damp, uncertain, and joyless climate than the first.

HEIGHT OF THE HUMAN SPECIES.

M. Silbermann, secretary of the French section of the Association for International Uniformity of Weights and Measures, shows that the average height of the male and female population of France, taken in a certain position which he names the "geometric," is 1.600040 metres, or two metres if (in the same position) the hands are comfortably extended over the head. Two individuals laid lengthwise, with fingers touching, would thus measure four metres, which he terms the base of the harmonic proportions of the human race. Thus this harmonic base is four times one metre, just as the meridian is four times ten million metres, and the relation of the two integers is as 1 to 10,000,000. From these considerations he draws proof of the equality of the sexes, as they exhibit woman, not as a complement to the male portion of creation, but as constituting of right half the human family, "as determined by Christian philosophy and the laws of the most civilized people," in which latter category we cannot, according to this text, at present be arranged, as our law still commits the barbarism of regarding a married woman as completely merged in the existence of her husband. Pursuing his calculations, M. Silbermann arrives at the conclusion that the average height of the human race has remained unchanged since the Chaldean epoch, four thousand years ago.

Human Proportions. — M. Bonomi of France, in a recent publication, describes a curious invention of the English sculptor, Gibson, for producing strictly geometrical elevations of the human figure, which accord exactly with the proportions assigned to it in the "Canon of Vitruvius." This canon is supposed to be founded on the celebrated proportions laid down by Polycletus. They display some most curious geometrical relations between the parts of the human figure. Thus the measure from the crown of the head to the sole of the foot is exactly equal to the measure from the extremity of one hand to the extremity of the other when the arms are extended; the face, from the chin to the highest point of the forehead, whence the hair begins, is a tenth of the whole stature; so also the hand, from the wrist to the extremity of the middle finger; the length of the foot is a sixth part of the height of the entire frame.

ON THE COLORING-MATTER OF CERTAIN FRESH-WATER SHELLS.

At a recent meeting of the Philadelphia Academy, Mr. Lea read extracts from letters of Dr. Lewis, of Mohawk, N. Y., on the subject of the coloring-matter of the nacre of the genus *Unio*, and exhibited some fine specimens to illustrate the subject. The following extracts will fully convey Dr. Lewis's ideas on this subject, which has much interest with the naturalist: —

I hinted something about *Uniones* being colored with an oxide or salt of gold. My reasons for this are derived from observing some singular phenomena in colors on submitting shells to the action of chloride of gold, and then bringing them in contact with tin. Whether a stannate of gold formed and precipitated on the shells or not, I cannot say; but the colors were very much intensified. It is to be remarked that the colors of such shells as *Unio*

complanatus and of *U. ligamentinus*, when colored, are such as result from the presence of gold in a state of atomic division and dissemination in a semi-opaque body. I think nitro-muriatic acid, with a minute trace of gold in it, if applied to shells, will produce colors, but I never have satisfactorily demonstrated this. My observations are derived from having once used acid in which was a small quantity of gold, too small to be reclaimed.

I notice that colors are most brilliant in regions where gold may be suspected. In the lake regions of the Western States minerals are abundant, and the conditions are not incompatible with the supposition that gold is sparingly disseminated among them, in quantities too small, perhaps, to be available, but no doubt it is there.

As regards colors in the nacre of *Uniones*, you are correct in saying that *Uniones* are colored where there is no gold. But there are some species that are not colored unless you find them in some particular localities. If that is taken into consideration, we shall, perhaps, be more ready to accept the gold theory. Modern investigations show that gold exists in soils that, until they were rigidly tested, were not suspected to contain it. In fact, I am disposed to believe that gold is more universally disseminated than is generally supposed.

But the question is one I take no particular interest in, except that it presents itself incidentally. I know one fact that you also know: that of two streams producing identically the same species, one will give a large proportion of white nacres, and the other will present colored nacres; and usually we also notice another phenomenon, a greater brilliancy of nacre where rich colors abound. In this case, I have my private opinion that gold produces its peculiar tonic effect, for tonic it is under certain circumstances, by increasing the secretions.

To have gold in a shell, it is not necessary that it should be an oxide. It is only necessary it should have been received into the circulation of the animal in solution, as chloride, or some other possible soluble form that chemistry has not brought to light; and, when once in the circulation, it may be eliminated, by being deprived of its solving principle, and excreted or secreted with the other solid matter that enters into the formation of the shell. The stannate of gold, or purple of Cassius, may be wholly deprived of the tin associated with it, yet retain its purple color, and its condition of atomic division, if so you are pleased to call it. But I only offer this as suggestive of something for those interested to follow further. I am not enough of a chemist to develop any facts out of a suspicion of this kind.

Mr. Lea remarked, after reading the above extracts, that the purple, pink, and salmon colors of many of our American *Unionidæ* had had his attention from the period of his first studying this beautiful and interesting family, more than thirty years since. Without having experimented himself upon them, he was aware that no chemist had been able to detect the presence of a metal or other elementary body. He therefore thought it likely to be caused by the presence of some organic body which had not yet been detected; such is supposed by chemists to be the case with the colored fluates of lime, colored quartz, etc. What Dr. Lewis states as regards the colors being more frequent and more intense in the waters of Michigan, and in the streams leading into the northern great lakes from the southern side, is very true. The *Unio rectus* is usually white in the Ohio, though sometimes tinted with purple and salmon-color, while in the more northern waters it is usually of a fine, rich purple or salmon. Two specimens from the upper Mississippi,

brought by Dr. Cooper, were exhibited by Mr. Lea, which were of exquisite purple and salmon. The *Unio ligamentinus* has probably never been found pink or purple in the Ohio; while at Grand Rapids, Mich., those with a fine pink and salmon-color are very common. The *Margaritana margaritifera* of Columbia river and its tributaries has a fine purple nacre in almost all the specimens, rarely white, while those in the rivers of Pennsylvania, Connecticut, and Massachusetts are almost universally white, as those from the northern part of Europe are also.

Dr. Draper had informed Mr. Lea that he had calcined some of these purple shells, but that they had burned white, and he had not detected any metallic substance in their composition. The subject was certainly one well worth the pursuit, as no doubt could remain that the color was derived from some foreign substance entering into the composition of some individuals, while others were free from it. It was not an uncommon case to find the dorsal portion of the nacre to be pink or purple, while the other portions were white; and this was also sometimes the case with the cavity of the beaks. Mr. Lea did not believe the color arose, as some persons supposed, from the structure of the surface of the nacre dividing the rays of light by thin laminations. This division of color was exhibited in almost every species, and is what naturalists call the "pearly hue," oftentimes of great beauty, but quite a different matter from the pink, purple, and salmon-color of the mass of the carbonate of lime composing the substance of the valves.

ON THE NUMBER OF THE UNIONIDÆ IN THE UNITED STATES.

At a recent meeting of the Philadelphia Academy, Mr. Isaac Lea gave the following statement respecting the number of the *Unionidæ* in the United States:—

Unio, ...		465 species.
Margaritana, ...		26 "
Anodonta, ...		59 "
		550
To these may be added new species in his cabinet not yet described, ...		30
		580
And to these may be added, for North America, known to inhabit Mexico, Honduras, Central America, and one in Canada,		
Unio, ...	29	
Anodonta, ...	8	
		37
		617

Mr. Lea further observed that we have not in North America either of the genera *Triquetra* (*Hyria*, Lam.), *Prisodon* (*Castalia*, Lam.), *Monocondylæa*, *Mycetopus*, *Byssandonta*, or *Plagiodon*. They are all emphatically South American types, while there does not seem to inhabit the southern half of America a single species of *Margaritana* (*Alasmodonta*, Say.). Ferussac has described a species (*A. incurva*) as coming from South America, but there is reasonable doubt of it. The *Monocondylæa* and *Margaritana* seem mutually to replace each other. The *Uniones* and *Anodontæ* prevail in both parts of

the continent over all the other genera, both as to numbers and universality of distribution. The genus *Mulleria* (*Acostea*, D'Orb.) has only been found in the tributaries of the Magdalena, in New Granada.

In reflecting on the profusion of this kind of animal life in the United States, the naturalist is astonished at the great number of forms characteristic of the various species; and he is the more struck with the extent of it, when a comparison is made with the small number of species which inhabit the continent of Europe, there not being in the fresh waters of that quarter of the globe more, perhaps, than ten species; viz. seven *Uniones*, one *Margaritana*, one *Monocondylæa*, and one *Anodonta*. Mr. Lea stated that he had taken great pains to procure specimens from all parts of Europe, and he was satisfied that there were ninety-eight synonyms made by European authors for the single species of *Unodontu cygnea*, Draparnaud, the *Mytilus cygneus* of Linnæus, and the synonymy is nearly as profusely erroneous in *Unio pictorum*, *Unio tumidus*, *Unio Batavus*, and *Unio littoralis*.

ASTRONOMY AND METEOROLOGY.

NEW PLANETS.

FIVE additional asteroidal planets have been discovered during the past year, making the whole number now recognized sixty-two.

The fifty-eighth asteroid was discovered March 24th, 1860, by Dr. Luther, of the Observatory at Bilk, Germany, and has received the name *Concordia*.

The fifty-ninth asteroid was discovered by M. Goldschmidt, of Paris, September 9th, and has received the name of *Danæ*.

The sixtieth asteroid was discovered by M. Chacornac, of Paris, September 12th, 1860.

The sixty-first asteroid was discovered September 14th, 1860, by Messrs. Förster and Lesser, of Berlin, Prussia, and has received the name of *Erato*.

The sixty-second asteroid was discovered by Mr. James Ferguson, of the National Observatory, Washington, D. C., September 15th, 1860, and has received the name of *Titania*.

VEGETATION ON THE MOON'S SURFACE.

On the surface of the moon are seen numerous streaks, or narrow lines, about a hundred in number, which appear, perhaps, more like long, narrow furrows than anything else. Sometimes they spread themselves on the lunar disk in straight lines; sometimes they are seen slightly curved; in every case they are shut in between stiff parallel borders. It has often been supposed that these furrows, the true nature of which has hitherto remained unknown, represent the beds of ancient, dried-up rivers, or rivers that have not yet ceased to flow. Other astronomers think they are streams of lava which have been vomited by lunar volcanoes, and which reflect the light of the sun with more intensity than the adjacent regions. M. Schwabe, a German astronomer, endeavors, however, to give them another explanation. He has published in the *Astronomische Nachrichten* some facts which tend to show that these lines are the result of a vegetation on the surface of the moon. According to the author, if the surface of the moon be examined attentively with a good telescope and a proper illumination, we discover between the lines or luminous furrows of the high mountain called Tycho, and on different other points, a quantity of very delicate parallel lines of a greenish tint, which were not visible some months before the observation, and which disappear some months after, to return again in the proper season. These lines, which are darker than the adjacent parts, are apparently the result of vegetation;

and it is this vegetation which makes the sterile parts of the moon appear as bright luminous streaks. According to M. Schwabe, these lines of vegetation are more particularly visible in the very bright parts of the moon, which are circumscribed by a number of particularly prominent mountain peaks.

LEVERRIER'S NEW PLANET "VULCAN."

On the 2d of January, 1860, M. LeVerrier communicated to the Academy of Sciences a remarkable paper on the theory of Mercury. In studying the twenty-one transits of that body over the sun between 1697 and 1848, he found that the observations could not be represented by the received elements of the planet, but that they could be all represented, nearly to a second, by augmenting by thirty-eight seconds the secular motion of the perihelion of Mercury. In order to justify such an increase we must increase the mass attributed to Venus one-tenth at least of its value, which, from sixty years' meridian observations, has been found to be the four hundred thousandth part of that of the sun. If we admit this increased mass of Venus, we must conclude, either that the secular variation of the obliquity of the ecliptic, deduced from observations, is affected with errors by no means probable, or that the obliquity is changed by other causes wholly unknown to us. If, on the other hand, we regard the variation of the obliquity of the ecliptic, and the causes which produce it, as well established, we must believe that the excess of motion in the perihelion of Mercury is due to some unknown action.

"I do not intend," says M. LeVerrier, "to decide absolutely between these two hypotheses. I wish only to draw the attention of astronomers to a grave difficulty, and to make it the subject of a serious discussion." We must, therefore, as he suggests, find a cause which shall impress upon the perihelion of Mercury these thirty-eight seconds of secular motion, without producing any other sensible effect upon the planetary system.

M. LeVerrier then shows that a planet between Mercury and the sun, the size of Mercury, situated at half his mean distance from the sun, if moving in a circular orbit slightly inclined to that of Mercury, would produce the thirty-eight seconds of secular motion in his perihelion. But when he considers that such a planet would have certainly a very great brightness, he cannot think that it would be invisible at its greatest elongation, or during total eclipses of the sun.

"All these difficulties," he adds, "disappear, if we admit, in place of a single planet, small bodies circulating between Mercury and the sun;" and he thinks their existence not at all improbable, seeing that we have already a ring of fifty-eight such bodies between Mars and Jupiter.

A short time subsequent to the publication of this paper, M. LeVerrier received a communication from a physician in very humble circumstances, in the little town of Orgeres, in France, — M. Lescarbault, — stating that he had "actually discovered an intra-Mercurial planet making a transit across the disk of the sun."

The circumstances of the case were briefly as follows: —

M. Lescarbault, who had studied astronomy solely from a love of the science, conceived the idea, as far back as 1845, of observing systematically the sun, with a view of seeing whether any planet other than Venus or Mercury could be detected in making transit across the solar disk. He

accordingly provided and arranged a rude apparatus, and commenced observing, whenever the duties of his profession afforded him sufficient leisure; and at length, on the 26th of March, 1859, about four o'clock in the afternoon, he saw a small dark body enter the sun's disk. Its circumference was well defined. Its angular diameter, as seen from the earth, was very small; and he estimated it as less than one-fourth the size of Mercury, which he had seen with the same telescope, and the same magnifying power, when it passed over the sun on the 8th of May, 1845. His calculations from his data also led him to the conclusion that the planet's distance from the sun was about 0.1427, its period less than twenty days, its ascending node situated at about thirteen degrees of longitude, and its inclination between twelve and thirteen degrees.

Possessed of a sensitive and reserved nature, and doubting the reality of his discovery, M. Lescarbault hesitated to make it known, and it was only after vainly waiting nine months, to verify his observation by another view of the object, that he prepared a letter, narrating what he thought he had seen, and sent it to LeVerrier. The latter, considering that his official position (Director of the National Observatory) required that he should probe such statements to the bottom, and prevent the success of anything like an attempt to palm off a fraud on the public, at once visited Orgeres, and, accompanied by a single friend, made his way direct and unannounced to the house of M. Lescarbault. The following graphic account of what here passed is given by M. Moigno, in the "*Cosmos*," and is stated to be given nearly as recounted by M. LeVerrier to an assembly of friends on his return: —

On their arrival, M. LeVerrier knocked loudly at the door, which was opened by the doctor himself, but his visitor declined to give his name. The simple, modest, timid Lescarbault, small in stature, stood abashed before the tall LeVerrier, who, in blunt intonation, addressed him thus: "It is then you, sir, who pretend to have discovered the intra-Mercurial planet, and who have committed the grave offence of keeping your discovery secret for nine months! I warn you that I have come with the intention of doing justice to your pretensions, and of demonstrating either that you have been dishonest or deceived. Tell me unequivocally what you have seen." The lamb-like doctor trembled like an aspen-leaf at this rude summons, and stammered out the following reply: —

"On the 26th of March, about four o'clock, I turned my telescope to the sun, when to my surprise I saw, at a small distance from its margin, a black spot, well defined, and perfectly round, advancing upon the disk of the sun. A customer called me away, and hurrying him off as fast as I could, I came back to my glass, when I found the round spot had continued its transit, and I saw it disappear from the opposite margin of the sun, after a projection upon it of an hour and a half."— "You will then have determined," asks LeVerrier, "the time of the first and last contact; and you are aware that the observation of the first contact is one of such extreme delicacy that professional astronomers often fail in observing it?"— "Pardon me, sir," replies the doctor, "I do not pretend to have seized the precise moment of contact. The round spot was upon the disk when I first perceived it. I measured carefully its distance from the margin, and, expecting that it would describe an equal distance, I counted the time which it took to describe this second distance, and I thus determined approximately the instant of its entry."— "To count the time is easy to say, but where is your chronometer?"— "My chronometer is a watch with minutes, the faithful companion of my professional

journeys."—"What! with that old watch, showing only minutes, dare you talk of estimating seconds? My suspicions are already too well founded."—"Pardon me," was the reply, "I have also a pendulum which nearly beats seconds."—"Show me this pendulum," says LeVerrier. The doctor goes up stairs, and brings down a silk thread, to which an ivory ball was suspended. "I am anxious to see how skilfully you can thus reckon seconds." The lamb acquiesces. He fixes the upper end of the thread to a nail, and after the ivory ball has come to rest, he draws it a little from the vertical, and counts the number of oscillations corresponding with a minute on his watch, and thus proves that his pendulum beats seconds. "This is not enough," replies the lion; "it is one thing that your pendulum beats seconds, but it is another that you have the sentiment of the second beaten by your pendulum in order that you may count the seconds in observing."—"Shall I venture to tell you," says the lamb, "that my profession is to feel pulses and to count their pulsations? My pendulum puts the second in my ears, and I have no difficulty in counting several successive seconds."

"This is all very well for the chapter of time," says the director; "but, in order to see so delicate a spot, you require a good telescope. Have you one?" — "Yes, sir; I have succeeded, not without difficulty, privation, and suffering, to obtain for myself a telescope. After practising much economy, I purchased from M. Cauche, an artist little known, though very clever, an object-glass nearly four inches in diameter. Knowing my enthusiasm and my poverty, he gave me the choice among several excellent ones; and, as soon as I made the selection, I mounted it on a stand, with all its parts; and I have recently indulged myself with a revolving platform, and a revolving roof, which will soon be in action." The lion went to the upper story, and satisfied himself of the accuracy of the statement. "This is all well," says he, "in so far as the observation itself is concerned; but I want to see the original memorandum which you made of it."

"It is very easy," answered the doctor, "to say you want it; but though this note was written on a small square of paper, which I generally throw away or burn when it is of no further use, yet it is possible I may still find it." Running with fear to his *Connaissance des Temps*, he finds the note of the 26th March, 1859, performing the part of a marker, and covered with grease and laudanum. The lion seizes it greedily, and, comparing it with the letter which M. Vallée had brought him, he exclaims: "But, sir, you have falsified this observation; the time of emergence is four minutes too late." — "It is," replied the lamb. "Have the goodness to examine more narrowly, and you will find that the four minutes is the error of my watch, regulated by sidereal time." — "This is true; but how do you regulate your watch by sidereal time?" — "I have a small telescope, — here it is, — which you will find in such a state as to enable me to tell the time to a second, or even to some fractions of a second."

Satisfied on this point, LeVerrier then wished to know how he determined the two angular coördinates of the points of contact, of the entry and emergence of the planet, and how he measured the chord of the arc which separates these two points. Lescarbault told him that this was reduced to the measuring the distances of these points from the vertical and the angles of position, which he did by the systems of parallel axes we have mentioned, and the divided circle of card-board placed upon his finder.

LeVerrier next inquired if he had made any attempt to deduce the planet's distance from the sun from the period of four hours which it required to

describe an entire diameter of the sun. The doctor confessed that he had made attempts to do this, but, not being a mathematician, he had not succeeded; and that this failure was the reason why he had delayed the announcement of his discovery. LeVerrier having asked for the rough draught of these calculations, the doctor replied: "My rough draughts! Paper is rather scarce with us. I am a joiner, as well as an astronomer. I calculate in my workshop, and I write upon the boards; and when I am done, I plane them off and begin again. But I think I have preserved them." On visiting the shop, they found the board, with all its lines and numbers still unobliterated.

The Parisian savan was now convinced that Lescarbault had really seen the planet whose existence he had himself foretold. Turning to the doctor, he revealed his personality, and congratulated his humble brother on the magnificent discovery thus confirmed. It was the event in the Orgeres physician's life. Honors poured in upon him. The cross of the Legion of Honor was sent to him from Paris. His name was at once enrolled in the lists of the leading scientific academies of Europe, and his professional brethren in Paris, anxious to testify of their regard, invited him to a public banquet in Paris, in the Hotel de Louvre. Other similar offers were made him from other cities in France; but he declined all invitations, pleading as an excuse his simple and retired habits, and the difficulty of leaving the patients under his charge.

LeVerrier, from a careful examination of all of Lescarbault's data, considers that the new planet — to which he gives the name of Vulcan — is one-seventeenth of the bulk of Mercury, which is much too small to account for all the perturbations of the latter. He concludes that it performs its journey round the sun in nineteen days seven hours, and that half the major axis of its orbit is equal to 0.1427, taking half the major axis of the earth's orbit as unity. On account of its limited orbit, it would never be more than eight degrees from the sun, which, with its feeble light, will account for its not having been observed before. LeVerrier also conjectures that this small body forms one of a group of planets between Mercury and the sun, which yet remain to be discovered.

The publication of these facts early in the past year excited the greatest sensation in the scientific world, and since then astronomers of all ranks have been anxiously watching for the reäppearance of the new planet during the time when it was likely to make its transit across the sun. No rediscovery of it, however, has yet been made; but the searching of astronomical records has brought to light many interesting cases, in which a round black spot has been seen upon the solar disk. M. Wolff, of Zurich, has given a list of not less than twenty observations, or affirmations, made since 1762, that a black spot has passed across the sun; and Mr. Carrington, of England, has added other cases, the most important of which are contained in the following list:

Dlaudacher, ...	1762, end of February.
Lichtenberg, ...	1763, November 19th.
Hoffmann, ...	1764, beginning of May.
Scheuten and Crefeld, ...	1764, June 6th.
Daugos, ...	1798, January 18th, 2 P. M.
Fritsch, ...	1802, October 10th.
Capel Lofft, ...	1818, January 6th, 11 A. M.
Stark, ...	1819, October 9th.

Stark,[1]	1820, February 12th, 12h.
Steinhübel, ...	1820, February, 12th.
Schmidt, ...	1847, October 11th, 9 A. M.

Upon comparing the three observations of Daugos, Fritsch, and Stark, made in 1798, 1802, and 1819, M. Wolff found that they were satisfied by a planet whose period of revolution is thirty-eight and a half days, or, what is the same thing, nineteen and a quarter days, which agrees so remarkably with the number 19.7, deduced by LeVerrier from the observations of Lescarbault, that we cannot ascribe it to chance.

Upon the supposition that the black spots seen upon the sun by the astronomers above mentioned are bodies between Mercury and the sun, M. Wolff is of opinion that the observations can only be reconciled by the admission of at least three intra-Mercurial planets.

The history of the discovery of this supposed new planet unfortunately does not close here, inasmuch as an eminent astronomer, and that astronomer a Frenchman, has presented himself boldly in the face of Europe, not only to question the existence of such a body, but to charge its discoverer with dishonesty, and impugn the very theoretical principles on which one of the greatest astronomers of the age had foretold its discovery.

M. Liais, a French astronomer in the service of the Brazilian government, in a published paper, asserts:

1. That the observation of M. Lescarbault is false.

2. Contrary to the assertion of M. LeVerrier, every planet nearer the sun than Mercury will be more visible, with telescopes, in the vicinity of the sun than he is.

3. That in eclipses of the sun the planet of Lescarbault has not been seen.

4. M. LeVerrier's hypothesis, that there is a powerful disturbing cause between Mercury and the sun, is founded on the supposition that astronomical observations have a precision of which they are not susceptible.

1. In support of the first of these bold assertions, our author states that, at the very time when the French astronomer was looking at the black spot on the sun's face, he, M. Liais, was examining the sun with a telescope of

[1] This black spot was nearly twice the apparent diameter of Mercury. "At noon," says Canon Stark, "this spot was 11′ 20″ distant from the east limb, and 14′ 17″ from the south limb of the sun; and at 4h. 23m. in the evening it was no longer to be seen. The appearance was rather indicative of the transit of a planetary heavenly body, having its path included within that of Mercury, than of a solar spot." — *Meteorologische Jahrbuch*, 1820.

This remarkable observation has been confirmed, says Mr. Carrington, in a passage of a letter from Olbers to Bessels, dated 20th June, 1820 (*Corr.* v. ii., p. 162): "What do you say to Steinhübel's observation of a dark, round, well-defined spot, which on the 12th of February of this year completed its transit across the sun's disk in five hours? If the thing is a fact, it indicates a planet interior to the orbit of Mercury."

The spot, called small and sub-elliptic, and six or eight seconds in diameter, seen by Capel Lofft on the 6th January, 1818, was observed about 2½h. P. M., considerably advanced on the sun's disk, and a little west of the sun's centre. It was seen also by Mr. Acton. "Its rate of motion seemed inconsistent with that of the solar rotation, and both in figure, density, and regularity of path, it seemed utterly unlike floating scoria. In short, its progress over the sun's disk seems to have exceeded that of Venus in transit." — *Monthly Magazine*, January 10, 1818.

twice the magnifying power, and did not perceive it. This observation was made in the bay of Rio Janeiro, at St. Domingos, when M. Liais was carefully determining the decrease in the luminosity of the sun from its centre to its circumference, and from its equator to its poles. The first of these observations was made between 11h. 4m. and 11h. 20m., and, from the interruption of clouds, the second was made between 12h. 42m. and 1h. 17m., on the very part of the sun where M. Lescarbault saw the planet enter, and at a time when it must have been during a period of twelve minutes on the sun's disk, and 1′.4 from its margin. "This quantity," says M. Liais, "is too great to be accounted for by the difference of the parallaxes of Orgeres and St. Domingos; and, consequently, when I made my last comparison, I ought to have seen upon the sun the black spot in question if it had been seen at Orgeres." It is certainly not easy to conceive how M. Liais could have missed seeing the black spot when he was using a fine telescope, and making such a nice observation on the light of the sun's disk at the very place where the planet should have been; and had he continued his observations even for a few minutes longer, we should have admitted the force of his argument; but twelve minutes is so short a time, that it is just possible that the planet may not have entered upon the sun during the time that he observed it. Still, however, he is entitled to assert, as he does, "that he is in a condition to deny, in the most positive manner, the passage of a planet over the sun at the time indicated."

M. Liais proceeds to support his astronomical fact by a moral argument, which, we think, has not much force. He says, what is true, that Lescarbault contradicts himself in having first asserted that he saw the planet enter upon the sun's disk, and having afterwards admitted to LeVerrier that it had been on the disk some seconds before he saw it, and that he had merely inferred the time of its entry from the rate of its motion afterwards. "If this one assertion, then," says M. Liais, "be fabricated, the whole may be so;" a conclusion which we cannot accept. These arguments M. Liais considers to be strengthened by the assertion, which, as we have seen, perplexed LeVerrier himself, that if M. Lescarbault had actually seen a planet on the sun, he could not have kept it secret for nine months.

2. The assertion of our author, in opposition to that of LeVerrier, that the planet, if one existed, ought to be seen in the vicinity of the sun, is not so easily answered.

In support of this opinion, he enters into an elaborate calculation of the brightness of the planet Vulcan compared with that of Mercury. He asserts that, from its proximity to the sun, it must be seven and one-third times brighter than Mercury. But Mercury has been seen by himself and others within 7° or 8° of the sun, and, therefore, assuming the diameter of Vulcan to be 2″ 5 (for which he assigns good reasons from Lescarbault's observations), the total light which it sends to the earth will be nearly double that of Mercury; and, consequently, Vulcan, or LeVerrier's Ring of Planets, ought to have been frequently seen by astronomers in the vicinity of the sun, when they were searching for planets and comets in that locality.

3. The assertion that the planet of Lescarbault has not been seen during eclipses of the sun, is of course true.

As the planet Mercury has been frequently observed during solar eclipses, we might reasonably expect to have seen Vulcan; but during the many observations which were made in the vicinity of the sun during the time

of the total eclipse of July 1860, no appearance of any intra-Mercurial planet was detected.

Taking, then, into consideration the numerous observations that have been made on the sun and in its vicinity by so many astronomers, and with such fine telescopes, M. Liais concludes "that if the motion of the perihelion of Mercury is due to the attraction of matter lying between the sun and this planet, this matter does not form planets, properly so called, but must be in a state of cosmical dust, and form a part of the solar nebulosity or zodiacal light."

4. M. Liais's last observation, questioning the existence of a disturbing force requiring for its cause the existence of a planet or planets, merits, doubtless, the attention of astronomers. The motion of the perihelion of Mercury has been deduced from twelve observed passages of this planet. Admitting the time of the planet's entrance upon the sun's disk to be affected with refraction, M. Liais has obtained, by calculation, a motion of the perihelion so much less than that assumed by LeVerrier, that he can account for it by supposing the mass of Venus to be from the tenth to the fifteenth greater than it is supposed to be. By admitting a possible error in the obliquity of the ecliptic of two and one-half seconds, and, consequently, an increase of one-tenth in the mass of Venus, M. Liais asserts that the whole motion in the perihelion of Mercury may be explained; and he further asserts that, by abandoning the invariability of the mean motions, which supposes a constancy in the masses, of which there is no proof, the position of Mercury may be explained without supposing so great a motion in his perihelion as has been alleged.

To these remarkable positions assumed by M. Liais no reply has been made by either LeVerrier or Lescarbault. As already stated, however, since the announcement of the discovery the sun has been anxiously observed by astronomers; and the limited area around him in which the planet must be, if he is not upon the sun, has doubtless been explored with equal care by telescopes of high power and processes by which the sun's direct light has been excluded from the tube of the telescope as well as the eye of the observer; and yet no planet has been found. This fact would entitle us to conclude that no such planet exists, if its existence had been merely conjectured, or if it had been deduced from any of the laws of planetary distance, or even if LeVerrier or Adams had announced it as the probable result of planetary perturbations. If the finest telescopes cannot rediscover a planet that has a visible disk, with a power of three hundred, as used by Liais, within so limited an area as a circle of sixteen degrees, of which the sun is the centre, or rather within a narrow belt of that circle, we should unhesitatingly declare that no such planet exists; but the question assumes a very different aspect when it involves moral considerations. If, after the severe scrutiny which the sun and its vicinity will undergo, no planet shall be seen, and if no round black spots distinctly separable from the usual solar spots shall not be seen on the solar disk, we will not dare to assert that it does not exist. We cannot doubt the honesty of M. Lescarbault, and we can hardly believe that he was mistaken. No solar spot, no floating scoria, could maintain, in its passage over the sun, a circular and uniform shape; and we are confident that no other hypothesis but that of an intra-Mercurial planet can explain the phenomena seen and measured by M. Lescarbault — a man of high character, possessing excellent instruments, and in every way competent to use them well, and to describe clearly and correctly the result of his

observations. Time, however, tries facts as well as speculations. The phenomena observed by the French astronomer may never be again seen, and the disturbance of Mercury, which rendered it probable, may be otherwise explained. Should this be the case, we must refer the round spot on the sun to some of those illusions of the eye or of the brain which have sometimes disturbed the tranquillity of science. —*North British Review.*

SOLAR ECLIPSE OF JULY 18TH, 1860.

The total eclipse of the sun, which occurred July 18th, 1860, was probably more fully and carefully observed than any former similar phenomenon, and the results, as might have been expected, are correspondingly valuable and interesting. We propose, in the present article, to give a popular *résumé* of the most important of these results, so far as they have been laid before the public.

In this country, an expedition, under the auspices of the Coast Survey, and under the general charge of Professor Stephen Alexander, of Princeton, N. J., aided by President Barnard, of the University of Mississippi, Professor Smith, of the Naval School of Annapolis, and other scientific men, proceeded in a government vessel to Cape Chidley, Labrador, the most favorable point on the Atlantic coast for observing the totality of obscuration of the solar disk. This expedition selected an observing station a few seconds short of 59° 48′ latitude; longitude, by chronometer, 4h. 16m. 53s. W.; while the track of the central eclipse left the eastern coast of Labrador in lat. 59° 51½′. The weather on the day of the eclipse was not entirely favorable; and just previous to the time of the sun's total immersion, a thin veil of clouds intervened between it and the observers, not dense enough to intercept the direct rays of the luminary, but too dense to allow the corona surrounding the dark moon during total obscuration to be visible. One observer was, however, fortunate enough to catch one point of brightness and to fix its position in this corona. The color of this bright point was white, and not ruddy.

The whole astronomical corps observed the breaking up of the last line of solar light lingering before total obscuration into the fragments commonly called "Baily's Beads," from Francis Baily, President of the Royal Astronomical Society, by whom they were described in the *Mem. Astr. Soc.* for 1837, as observed by him in the annular eclipse of 1836. These fragments were very evanescent, and were not preceded by those longer dark filaments or ligaments noticed by Mr. Baily on the same occasion, and, more or less perfectly, by others since. At the emergence of the sun the beads were not noticed, owing probably to the veil of clouds. The darkness which prevailed during total obscuration was not as remarkable as had been anticipated by most of the observers. Mr. Barnard, in a communication to *Silliman's Journal* (from whose statement the above facts are gathered), states that he "found no difficulty in making pencil notes at this time, or in reading lines written in pencil in other parts of his note-book. It was not necessary to bring the book nearer to the eye than usual."

Observations on the eclipse were also made, under the direction of the United States Coast Survey on the Pacific coast, at Steilacoom, Washington Territory, by Lieutenant Gillis, U. S. A. From the report made by Lieut. Gillis to the Superintendent of the Coast Survey we derive the following particulars: The sun at this locality rose eclipsed. At the moment of total-

ity, beads of golden and ruby-colored light flashed almost entirely around the moon, not constant even for a second at one point, but fitfully flashing, as reflection from rippled water, and as mutable in the respective places of the colors. This bead-thread broke up suddenly, when, for the first time, protuberances were noticed beyond the following limb of the moon. The largest one was in the form of a flattened cone or pyramid of cumulus cloud, about one minute in height by two minutes broad at the base. The cloud was not a uniform mass, but apparently an aggregation of small ones, and its general tint was a rosy pink, with occasional spots and edges of yellowish white light, as though sunlight shone obliquely through them. This was an extremely beautiful sight, and occupied Mr. Gillis so intently that he lost the beat of the chronometer. It was then so dark that he could not see the second-dial on the gold chronometer without a lantern. "Raising my face to the telescope," says Lieutenant Gillis, "a most extraordinary scene was apparent. Over the moon's black disk colors of the spectrum flashed in intersecting circles of equal diameter with that body, and each apparently revolving towards the lunar centre. The moving colors were not visible beyond the moon, but a halo of virgin white light encircled it, which was quite uniformly traceable more than a semi-diameter beyond the black outline. This corona was composed of radial beams, or streamers, having slightly darker or fainter interstices rather than a disk of regularly diminishing or suffusing light; but the gorgeous appearance of the spectrum circles, with their incessantly changing bands of crimson, violet, yellow, and green, thoroughly startled me from the equanimity with which the preceding phenomena had been observed. Nor were these colors physiological results from a change of position of the body, or of preceding strain of sight in efforts to recognize the division of the second's dial, in darkness, and subsequent direction of the eye towards the sunlight, for they continued visible with the telescope at least ten seconds longer. As near as it was possible to estimate, the breadth of each spectrum circle was about two minutes. The green colors were not darker than the tint usually called pea-green, and were on the edges farthest from their respective centres; but neither of the lines seemed to retain a definite position, and I was irresistibly drawn to their contemplation, to the neglect of all the changes that might have been taking place in the protuberance and corona.

"They vanished with the first appearance of sunlight beyond the western limb of the moon, their sudden obliteration causing me to utter an exclamation which was regarded as the signal for noting the time, a datum whose importance had been wholly forgotten in the fascination thus caused. I cannot liken them to anything so nearly as to the image seen in the kaleidoscope."

An expedition to the mouth of Saskatchewan River, Lake Winnipeg, was disappointed in the weather, and made no scientific observations, the sun, during the eclipse, being obscured with thick clouds.

In Europe, the only point where the obscuration of the sun's disk was total was Spain; and here the most eminent astronomers of almost every country in Europe gathered — the British government alone placing two steamers at the disposal of their scientific corps. About fifty stations were occupied, by several hundred observers, among whom were LeVerrier, Airy, Whewell, Struvé, Madler, Secchi, and others.

Before totality commenced, the colors in the sky and on the hills are described as having been magnificent beyond all description; the clear sky in

the north assumed a deep indigo color, while in the west the horizon was pitch black, like night. In the east the clear sky was very pale blue, with orange and red-like sunrise, and the hills in the south were very red. On the shadow sweeping across, the deep blue in the north changed like magic to pale sunrise tints of orange and red; the colors increased in brilliancy; overhead, the sky was leaden. Some white houses at a little distance were brought nearer, and assumed a warm yellow tint. The eclipse-shadow, also, is mentioned by several observers. "Our position," says an astronomer who had his position at Moncayo, "was very near the central line, and we could distinctly mark the heavy black pall as it passed over us from the northwest to the southeast; but its course was very rapid, and it seemed to sweep past us like the legendary chase of the wild huntsman."

On the interesting question as to the degree of intensity of the darkness produced by a total eclipse, the testimony of observers seems to vary according to their position. The following are some of the statements: —

"The darkness during totality was less than might have been expected. It was easy to read and write the whole time, and no recourse to artificial light was necessary."— *Le Verrier, near Tarrazona.*

"The darkness was great; thermometers could not be read."— *M. Lowe, Fuente del Mar, near Santander.*

"For three minutes it certainly was very dark — much too dark to read, though I could just distinguish the figures on my watch; but the moment the least limb of the sun reäppeared, it was astonishing how instantly the light returned; and I can well understand how comparatively small is the diminution of light during a partial eclipse, even when the sun is almost completely hidden."— *Mr. Packe, summit of Moncayo.*

The effects on man and nature are also thus noticed. Says an observer at Santander: —

"The countenances of the men were of a livid pink. The Spaniards lay down, and their children screamed with fear."

Says an observer at Vittoria: —

"It is impossible to describe the awe which came over us all. I do not hesitate to say that the whole scene was by far the most wonderful I have ever beheld. There is no phenomenon in nature that can compare with it in interest."

Of the effects of the total obscuration on the brute creation, also, we have the most copious accounts. Mr. Lowe, from Fuente del Mar, writes: —

"Fowls hastened to roost, ducks clustered together, pigeons dashed against the sides of the houses, flowers closed (*Hibiscus Africanus* as early as five minutes past two); at 2:52 cocks began to crow (ceasing at 2:57 and recommencing at 3:05). As darkness came on, many butterflies which were seen about flew as if drunk, and at last disappeared; the air became very humid, so much so that the grass felt to one of the observers as though recently rained upon."

Father Secchi, the well-known astronomer of Rome, observed the eclipse from the summit of Mount St. Michael, in the desert of Palmas, in Spain, but did not see the phenomena of Baily's beads. He describes the corona, during the whole time of the total eclipse, as magnificent, but most brilliant on the side on which the eclipse began. Its light was uniformly of a beautiful silvery white, shading off gradually from the margin of the moon to the distance of about half its diameter. From this distance sheets of light shot off in certain directions, some of them as long as a diameter and a quarter

of the moon. He noticed red protuberances while the sun was disappearing behind the moon, and also just before it emerged. At this time he saw a very large number of them, and above all a red cloud, entirely detached, separated from the rest and from the lunar margin by a distinctly marked white space. Its figure was elongated; it was twisted and sharp at the extremities, and about thirty seconds in length by three in breadth. There were many smaller ones. In regard to these phenomena, he uses the following language: —

"My convictions upon the nature of that which I saw are that the phenomena were real, and that I truly saw the flames in the solar atmosphere, and clouds suspended in these flames; it would be impossible to imagine anything else, as, for example, that it might be some phenomena of diffraction or refraction. The clear graduation and distinct mingling of the peach-blossom colored light with the white photosphere was of a character so distinct that it can never be mistaken for any phenomena of interference, of refraction, or any illusion whatever. I do not doubt that it really appertains to the sun, and the structure of these suspended clouds tends to strengthen my conviction."

M. Petit, Director of the Observatory at Toulouse, graphically describes the red protuberances as follows: —

"I have measured the incandescent emanations, whose dimensions on this occasion were enormous, and whose form has proved to me, in the most conclusive manner, that they are immense clouds floating in the vast atmosphere of the sun. Two of them were as much as sixty thousand miles in thickness, and two hundred and forty thousand miles in length! Of these two a considerable part was separated from the solar disk by an extent of at least eighteen thousand miles — a circumstance which proves, beyond all doubt, that they are not mountains in the sun, as has been surmised. Their dimensions diminished from the side toward which the moon moved. I was able, during the brief duration of the phenomenon, to follow and measure the variation of these dimensions, and the result, as before, goes to prove that these peaks belong to the sun. Especially was I able, filled with a profound feeling of wonder and awe, to measure the height of the solar atmosphere, which, in its least dense and most irregular portion, extends to forty-five minutes of a degree, that is, at least one million five hundred thousand miles above the photosphere of the sun."

M. De La Rue, who was attached to the suite of Professor Airy, the Astronomer Royal of England, thus describes the phenomena of the eclipse as observed by his party: —

"Some minutes before the totality I distinctly saw the whole of the lunar disk, and a luminous prominence on the east of the zenith. This was quite visible, while the sun's image was reflected by a glass surface fixed at an angle of 45°, in the eye-piece, and the intensity of its light, consequently, much diminished. The upper surface of the glass diagonal reflector I had, however, silvered to the extent of one-half, and, as I brought into action the silvered half just previous to totality, I perceived a large sheet of prominences on the east. A little to the east of the zenith a brilliant cloud, quite detached from the sun, and at some distance from the moon, came into view.

"The brilliancy of these prominences was wonderfully great, and far exceeded that of the corona. They were not uniform in tint, and, to my eye, they did not in general present a red or rose color; two, however, had a

decided but faint rose tint. Much detail was visible in the protuberances, both of light, shade, color, and configuration. The side towards the sun was not brighter than the opposite side; but in some cases the more distant portions of the protuberances were fainter than the near portions. It is not improbable, therefore, that they consist of gaseous matter in an intense state of incandescence. The surface of some of the eastern luminous prominences next to the moon was, when first seen, very irregular, and far more so than was attributable to mountains as seen in profile on the moon's edge. This irregular outline may, however, be explained by supposing these prominences to have been first seen floating, like clouds in a transparent atmosphere, at some little distance from the sun's surface, and, consequently, from the moon's edge — a supposition which is supported by the fact that one such prominence or luminous cloud was seen distinctly detached, and at some distance from the dark moon. As the moon glided over the sun's disk, the inner outline of the prominences in the eastern hemisphere became less and less indented, and at last they were bounded by the nearly even outline of the moon's limb. As the eastern prominences became gradually covered, a mountain-like peak, seen at first as a mere point in the northwest quadrant, gradually grew in dimensions, then presented several points, and at last resembled somewhat a colossal ship in full sail; and, extending from this through an arc of 60°, there came into view in the northwest quadrant a long streak of luminous prominences, varying in breadth, and with a few points projecting outwards. This streak became very jagged in its inner outline as the moon glided off from it, just previous to the sun's reäppearance, when these luminous prominences presented the same phenomena as those on the eastern edge; that is, they appeared like clouds floating in a transparent atmosphere, a little distance from the sun.

"As the prominences which we see beyond the sun's limb on the occasion of a total eclipse are merely such as are, from their situation, seen in profile, it is fair to presume that such prominences must exist pretty generally diffused all over the sun's photosphere, and that they must be at all times visible either as light or as dark markings on the sun's disk. Whether they are the bright portions or faculæ, or the darker portions (not the spots) of the sun's mottled disk, or whether they may not in some cases appear more bright, and in others less bright, than the general brightness of the sun's disk, must still be a matter of conjecture. It is an interesting fact, however, that on the nineteenth and twentieth a large mass of faculæ, surrounding a group of small spots, came round into view by the sun's rotation, which must have occupied very nearly the position of the brightest portion of a large streak of prominences on the southeastern quadrant. The prominences in some cases did not project beyond the moon's limb to a greater extent than the thinnest line, but in others the prominence reached a distance of two minutes. The detached cloud before mentioned, when first seen, was about half a minute (14,000 miles) beyond the position occupied by the moon's dark limb. It presented a double curvature on its northern side, both curvatures being convex towards the north. It inclined, in a curved direction, at about an angle of 60° from a radius towards the east, and was a minute and a half (42,000 miles) long. As the moon glided onwards in her course, she approached it gradually, and at last touched the extreme point of this floating cloud, which glowed with all the brilliancy of one of our own terrestrial clouds at sunset. It presented a decided rose tint. At 72° from the north a protuberance, in shape reminding one of a boomerang, imprinted itself on

a collodionized plate, although it was not visible to me in the telescope. The stem was two minutes long (56,000 miles); the point was bent towards the north, inclining downwards over towards the extremity of the detached cloud. It is a very curious circumstance that this protuberance imprinted itself distinctly, although it did not attract the eye directed especially to that locality. This may be accounted for on the supposition that it emitted a feeble purple light.

"My own observations, and those of others, furnish an additional proof that the luminous prominences belong to the sun, and not to the moon; and this is placed beyond doubt by two photographs I obtained, at two different periods, during the totality. They show that the prominences retained a fixed position in regard to the sun, and that, as successive portions of the moon passed before them, they did not change either their form or appearance, except in so far that the moon, by passing over them, shut off one portion after another towards the east, while more was visible of those protuberances on the west; and fresh protuberances came into view, and were depicted in the second photograph. A more important inference, leading to the same physical conclusion, is, that the moon's disk distinctly slid between the upper and the lower prominences, by a quantity measurable on the photographs. This is confirmed by the Astronomer Royal's measures of angular position of the prominences.

"Just before and after the eclipse, sun-pictures were made; and during the progress of the eclipse thirty-one photographs were obtained, the times of which are carefully registered. These will serve hereafter to determine the path of the moon across the sun's disk, and other data, with considerable accuracy. The serrated edge of the moon is perfectly depicted in all the photographs, and in some of them one cusp of the sun may be seen blunted by the projections of a lunar mountain, while the other remains perfectly sharp. The indentations of the concave side of the luminous prominences, as seen in the photographs at the period of totality, are far greater than the well-marked profiles of the lunar mountains shown in the photographs of the other places of the eclipse. The surface of the sun, just bordering the moon's dark disk, is brighter for a short distance than the other portions,— a phenomenon deserving of attention.

"With the Kew Photo-heliograph the moon does not give the slightest trace of a picture with an exposure of one minute; the pictures of the luminous prominences, which were procured in the same time, are overexposed, and the corona has clearly depicted itself on both the plates; the light of the corona is therefore more brilliant than that of the moon."

M. LeVerrier observed the eclipse at Tarragona, in Spain, assisted by MM. Chacornac and Yvon Villarceau. In his official report to the French government, he says: "The first object I saw after the commencement of totality was an isolated cloud separated from the moon's border by a space equal to its own breadth, the whole about a minute and a half high by double that length. Its color was a beautiful rose, mixed with shades of violet, and its transparency seemed to increase even to brilliant white in some parts. A little below, on the right, two clouds lay superimposed on each other, the smaller above, and the two of very unequal brilliancy. The rest of the western edge of the disk, and the lower part, showed nothing more than the corona, the light of which was perfectly white and of the greatest brilliancy. But, thirty degrees below the horizontal diameter on the east, I discovered two lofty and adjoining peaks, the upper sides both tinted with rosy and

violet light, while the lower sides were brilliant white. I do not doubt that the toothed form I assign to these peaks is real, which, as it contrasted with that of the first appendages I have described, I verified with great care; moreover, in shifting the telescope, whose high power permitted a sight of only a small part of the solar disk at one time, I saw a third peak, a little higher, also tooth-formed, and resembling the two others in color and form, differing only in its larger dimensions. The remainder of the disk offered nothing remarkable.

"The visible part of the emergent sun, over its whole breadth and up to the height of seven or eight seconds, was covered by a bed of rosy clouds, which appeared to gain in thickness as they emerged from behind the disk of the moon."

The conclusion arrived at by LeVerrier respecting these rosy appendages is, that they do not, as has been supposed by some, belong to the moon, or to the earth's atmosphere, but to the sun, and that they should hereafter be designated as "solar clouds;" and, making an application of his conclusion, he adds: "A reconstruction, or even a complete abandonment, of the theory hitherto prevalent as to the physical constitution of the sun appears to me essential. It must give place to one far more simple. We have been hitherto assured that the sun was composed of a central dark globe; that above this globe existed an immense atmosphere of sombre clouds; still higher was placed the photosphere, a self-luminous, gaseous envelope, and the source of the light and heat of the sun. Where the clouds of the photosphere are rent, says the old theory, the dark body of the sun is seen in the spots which so frequently appear. To this complex constitution must be added a third envelope, formed of the accumulation of roseate clouds. Now, I fear that the greater part of these envelopes are only fictions; that the sun is a body luminous simply because of its high temperature, and covered by an unbroken layer of roseate matter, whose existence is now proved. This luminary, thus formed of a central nucleus, liquid or solid, and covered by an atmosphere, falls within the law common to the constitution of celestial bodies."

This opinion of LeVerrier is not, however, likely to be acquiesced in by all astronomers; and M. Faye, in presenting to the French Academy a long letter from Baron Feilitzsch with an account of his observations (also in Spain), declares it to be his opinion, as well as that of Baron F., that the eclipse of 1860 furnishes the most decisive evidence in favor of the opinion which refers the corona and the luminous clouds to simple optical appearances, and not to the essential constitution of the sun or of his atmosphere. M. Faye adds, that the opinion appears to be confirmed by a comparison of the results of other observers, — that the sun has no atmosphere, and that the appearances recorded are purely optical.

M. Praznowski, who observed the eclipse at Briviesca, in Spain, with special reference to the polarization of light, comes to the following conclusions: —

(1.) The light of the red protuberances is not polarized. In this respect they resemble clouds in our atmosphere. May we hence conclude that these are solar clouds, composed of particles, not gaseous, but liquid, or even solid? The high temperature of the sun leads us to infer that these clouds are constituted of very refractory matter.

(2.) The polarization of the corona proves that its light emanated from the sun, and was reflected. The bright, very decided, polarization, proves also that the gaseous particles from which it was reflected send the light to us reflected nearly at the maximum angle of polarization. For a gas this

angle is forty-five degrees; but in order to reflect light at this angle it must be near the sun. A solar atmosphere seems to furnish the necessary conditions.

In connection with the eclipse, some curious solar phenomena remarked in Brazil by M. Liais, who has been engaged there for some time in various scientific researches, may be of interest. On the 11th of April, 1860, about noon, the brightness of the sun was suddenly diminished so much that it might be looked at without pain to the eye, although the sky was remarkably clear and fine. At the same time several persons saw distinctly, with the naked eye, a star close to the sun, which, from its position, must have been the planet Venus. It was afterwards calculated that the brilliancy of Venus on that day was only three-fifths of that which would make it as distinct under ordinary circumstances, — a fact which proves that the obscuration of the sun was not due to atmospheric causes. Had the state of the atmosphere produced that effect, it would, of course, have rendered the planet still more invisible. This phenomenon is, therefore, considered by M. Liais as similar to those which are stated to have occurred in 1106, 1208, 1547, and 1706, and which have been attributed to the passage of cosmical clouds of asteroids across the sun's disk.

METEORIC PHENOMENA OF 1860.

Meteor of July 20th, 1860. — On the evening of July 20th, 1860, one of the most remarkable meteors on record appeared over a portion of the earth's surface at least a thousand miles in length (from N. N. W. to S. S. E.) by seven or eight hundred miles in width, or from Lake Michigan to the Gulf Stream, and from Maine to Virginia. The following approximative results respecting the direction of the path of the meteor, its height above the earth, etc., have been deduced by Mr. C. S. Lyman, of New Haven, Conn., from a comparison of some of the most reliable of the observations which were made upon it: —

1. The vertical plane in which the meteor moved cuts the earth's surface in a line crossing the northern part of Lake Michigan, passing through, or very near to, Goderich, on Lake Huron, C. W., Buffalo, Elmira, and Sing Sing, N. Y., Greenwich, Conn., and in the same direction across Long Island into the Atlantic.

2. In this plane the path that best satisfies the observation is sensibly a straight line approaching nearest to the earth (forty-one miles) at a point about south of Rhode Island, and having an elevation of forty-two miles above Long Island Sound, of forty-four over the Hudson, fifty-one at Elmira, sixty-two at Buffalo, eighty-five over Lake Huron, and one hundred and twenty over Lake Michigan. The western observations, however, which are few and imperfect, seem to indicate a somewhat greater elevation than this for the western part of the path. Possibly, therefore, its true form may have been a curve, convex towards the earth, resulting from the increasing resistance of the atmosphere as the meteor descended into denser portions of it. The observations made this side of Buffalo, which are somewhat numerous, and many of them good, are very well satisfied by the straight path already described. Further and more accurate observations beyond Buffalo are greatly needed for determining the true form and position of the orbit, both in respect to the earth's surface and in space.

3. The close approximation to parallelism to the earth's surface of the

eastern portion of the observed path leaves it a matter of doubt, considering the imperfection of the observations, whether the meteor finally passed out of the atmosphere and went on its way in a disturbed orbit, or descended gradually into the Atlantic. The former supposition is, perhaps, the more probable, especially if the path was curved, as above suggested, instead of a straight line.

4. The meteor exhibited different appearances in different parts of its course. It seems to have been observed first as a single body, more or less elongated, gradually increasing in brilliancy, throwing off occasionally sparks and flakes of light, until it reached the neighborhood of Elmira, N. Y. Here something of an explosion occurred, and the meteor separated into two principal portions, with many subordinate fragments, all continuing on their course in a line behind each other, and still scattering luminous sparks along their track, until a point was reached about south of Nantucket, where a second considerable explosion took place, and afterwards the principal fragments passed on till lost to view in the distance. [The distance out at sea at which it was seen is reported at between three and four hundred miles. — *Editor.*] The most trustworthy observations represent the meteor as disappearing while yet several degrees above the horizon (generally from three to six or eight degrees).

5. It is not easy, from the observations on hand, to determine with much accuracy the velocity of the meteor while passing through our atmosphere. A comparison of the most probable estimates of time with the length of the path observed gives a velocity ranging from eight to fifteen miles a second. Probably twelve or thirteen miles is a tolerable approximation. This, allowing for the earth's motion in its orbit, gives twenty-six or twenty-seven miles a second as the actual velocity of the meteor in space. Its relative velocity may have been much greater when just entering the atmosphere than after encountering its accumulated resistance.

6. The actual diameter of the luminous mass, taking its apparent diameter as nearly equal to that of the moon (the estimate of many observers nearest its track), must have been from one-fifth to one-third of a mile. Many estimates would make it much larger. The two principal heads, when passing New Haven, must have been from one to three miles apart.— *Silliman's Journal.*

The evening on which this meteor appeared was oppressively warm and close, and great numbers of people were, consequently, out of doors or at windows, in situations favorable for witnessing the phenomenon. The meteor first attracted attention by its light, and, on looking up, the majority of observers saw two balls of flame coursing across the sky, from west to east, "like two chariots of fire urging their way in some mysterious race over the mighty course of the firmament." The motion was majestic rather than rapid, and the apparent nearness of the flame to the earth caused many to suppose at first that it was merely a pyrotechnical display.

The meteor was seen by a gentleman in Boston through a telescope of considerable power. The observer chanced at the moment to be looking at the planet Mars, and seeing the light of the meteor, he turned his telescope upon it, and followed its course until it passed out of sight. He made a sketch of its appearance, showing that the train of sparks which it left behind came from the front of the mass, where, from the compression of the air being greatest, the combustion was most intense.

Professor G. P. Bond, of the Cambridge Observatory, considers it probable

that this meteor did not fall to the earth, nor was it wholly consumed, but, continuing on its course, passed out of the limits of our atmosphere while over the Atlantic Ocean, and resumed its original character as a wanderer in the planetary spaces.

Meteors of August 2d and 6th, 1860. — A meteor rivalling in brilliancy that of July 20th was extensively observed throughout the southern United States on the evening of August 2d, between ten and eleven o'clock, local time. It appears to have passed from east to west, vertically, over Tennessee at ten minutes past ten, Knoxville time. "From three to five minutes after the disappearance of the meteor, a report was heard, like the discharge of an eight-pounder, which was followed by a long rolling reverberatory sound of more than a minute's duration."

Another brilliant meteor was seen in the southwest, from New Haven and New York, between half-past seven and eight o'clock, on the evening of August 6th. It passed from south to north, and, notwithstanding the daylight still remaining, attracted attention over a wide extent of country.

Fall of Meteoric Stones at New Concord, Ohio.[1] — About one o'clock, on the first day of May, 1860, the people of Southeastern Ohio and Northwestern Virginia were startled by a loud noise, which was variously attributed to the firing of heavy cannon, to the explosion of steam-boilers, and to an earthquake. In many cases houses were jarred. The area over which this explosion was heard was probably not less than one hundred and fifty miles in diameter. The central point from which the sound emanated appears to have been near the southern part of Noble County, Ohio. At New Concord, Muskingum County, Ohio, there was first heard in the sky, a little southeast of the zenith, a loud detonation, which was compared to that of a cannon fired at the distance of half a mile. After an interval of ten seconds, another similar report; after two or three seconds, another; and so on, with diminishing intervals. Twenty-three distinct detonations were heard, after which the sounds became blended together, and were compared to the rattling fire of an awkward squad of soldiers, and by others to the roar of a railway train. These sounds, with their reverberations, are thought to have continued for two minutes. The last sounds seemed to come from a point in the southeast forty-five degrees below the zenith. The result of this cannonading was the falling of a large number of stony meteorites upon an area of about ten miles long by three wide. The sky was cloudy, but some of the stones were seen first as "black specks," then as "black birds," and finally falling to the ground. A few were picked up within twenty or thirty minutes. The warmest was no warmer than if it had lain on the ground exposed to the sun's rays. They penetrated the earth from two to three feet. The largest stone, which weighed one hundred and three pounds, struck the earth at the foot of a large oak tree, and after cutting off two roots, one five inches in diameter, and grazing a third root, it descended two feet ten inches into hard clay. This stone was found resting under a root which was not cut off, and is now in the cabinet of Marietta College. About thirty other stones were found, one of which had a weight of fifty-three pounds, and another of thirty-six and a half; and the entire weight of all the fragments discovered is estimated at about seven hundred pounds. All the stones have the same general appearance. They are irregular blocks, and are covered with the

1 From an account communicated by Prof. E. W. Evans to *Silliman's Journal.*

peculiar black meteoric crust. Internally they are of a bluish-gray color, and show numerous brilliant points of nickeliferous iron.

Professor C. U. Shepard thus reports on the composition of the large fifty-three-pound specimen: In its internal aspect it approaches the stone of Jekaterinoslaw, Russia (1825), though it is somewhat firmer and more compact. In crust the two are identical. It is also similar to the stone of Slobodka, Russia (August 10, 1808), and compares closely with those of Politz (October 13, 1819), of Nanjemoy, Maryland (February 10, 1828), and of Kuleschowka, Russia (March 12, 1811); but the crust is less smooth on the Ohio stone than in that of the latter. A pearl-gray peridot forms the chief constituent (above two-thirds) of the stone. This mineral is often rolled up into obscurely-formed globules, which are so firmly imbedded in the more massive portions of the same mineral as to be broken across on the fracture of the stone, which therefore presents a sub-pisiform appearance. Snow-white particles of Chladnite are thickly scattered in mere specks through the mass, and closely incorporated with the peridot. The nickelic iron, of a bright white color, is also everywhere thickly interspersed in little points. Pyrrhotine is less conspicuous, though often visible in rather broad patches; while black grains of chromite are easily distinguishable by the aid of a glass, and sometimes with the naked eye.

According to Professor Evans, of Marietta, Ohio, the results of the various observations give to the meteor a height of forty-one miles over the northern boundary of Noble County, a diameter of three-eighths of a mile, and a relative velocity of nearly four miles a second.

It was seen, through openings in the clouds, at various points along a line of sixty miles, extending from near Newport on the Ohio River to the neighborhood of New Concord. The evidence, upon the whole, does not indicate any descent of the body towards the earth between these limits, or any change in its size or appearance. From this fact, and the great height of the body, and the absence of all evidence that it was seen or heard in the northern part of the state or beyond, it seems probable that this meteor was not dissipated in the atmosphere, but passed out of it again. The shower of stones which came down near New Concord had probably been detached from the principal mass before the latter came into sight.

Dr. J. Lawrence Smith, of Louisville, Ky., after an examination of all the facts connected with this phenomenon, writes to *Silliman's Journal* that he is of the opinion that no fall of meteoric stones before recorded possesses so many points of interest as the one in question — surpassing even the far-famed fall at L'Aigle, in France.

Meteor of August 11, 1860. — During the past year the only fragment of the great meteor which exploded and was seen over a large district of New England and New York on the 11th of August, 1860,[1] has been examined by Professor Shepard, who reports respecting it, in *Silliman's Journal*, as follows: The crust of the stone found at Bethlehem (Albany County, N. Y.) is very peculiar. It is double the thickness of any in my collection, equalling that of thick pasteboard. It is perfectly black, and very open in its texture. The outer surface is rough, being nowhere perfectly fused, but only semi-vitrified. Without being fragile or carbonaceous, it nevertheless resembles in color, lustre, and porousness, certain surfaces of mineral charcoal. The

[1] See *Annual of Scientific Discovery*, 1860, pp. 415–17.

interior of the stone is equally peculiar, being loosely granular, the particles uniform in character, small, highly crystalline, and nearly transparent. They possess a brilliant lustre, being of a very light gray or greenish-white color. They resemble volcanic peridot more than any species of the augitic or feldspar family. Nickelic iron, of a bright white color, in delicate filaments and semi-crystalline grains, is thickly diffused through the mass; and these grains, as well as those of the peridotic mineral, are flecked with brilliant points of pyrrhotine (FeS). The specific gravity is 3.56. In general color and effect to the eye it approaches nearest to the Klein-Wenden stone (September 16, 1843); but it differs from this in being larger grained and looser in its texture.

Meteorites of Harrison County, Indiana. — A remarkable fall of meteoric stones took place in Harrison County, Indiana, on the 28th of March, 1859, which is thus reported on, in *Silliman's Journal*, by Professor J. Lawrence Smith, who visited the locality and personally investigated the facts connected with the occurrence. The time at which it occurred (four o'clock in the afternoon) rendered the phenomenon of ready observation. The area of observation was about four miles square, and wherever persons were about in that area the stones were heard hissing in the air, and then striking on the ground or among the trees. Hardly a single person in the immediate vicinity of the occurrence saw any flash or blaze, as was noticed by all who heard the report from a distance. Three or four loud reports, like the bursting of bombshells, were the first intimations of anything unusual. A number of smaller reports followed, resembling the bursting of stones in a limekiln. The stones were seen to fall after the first four loud explosions. Those who happened to be in the woods or near them heard the stones distinctly striking amongst the trees. In some places the noise of the falling stones in the woods alarmed the cattle and horses in the vicinity, so that they fled in terror. A peculiar hissing noise, during the fall of the stones, was clearly heard for miles around. A very intelligent lady described it as very much like the sound produced by pouring water upon hot stones. The air seemed as if all at once it had become filled with thousands of serpents.

Four specimens of this meteoric fall were found, the largest of which — weighing nineteen ounces — fell in the streets of Buena Vista, Ind., and buried itself in hard gravel to the depth of four or five inches. They are all covered by a very black vitrified surface, and when broken show the usual gray color of stony meteorites, interspersed with bright metallic particles. A chemical analysis of these fragments gave the usual meteoric constituents, viz., nickeliferous iron, phosphuret of iron and nickel, sulphuret of iron, olivine, pyroxene, and albite, with traces of cobalt and copper.

Shooting Stars of August 9–10, 1860. — Since the year 1837, at least, it has been found in the northern hemisphere, whenever the weather has permitted observation, that shooting stars have been unusually abundant during a period of several nights in August, gradually increasing in numbers for a few days up to the tenth of the month, and then gradually diminishing in frequency. While every other meteoric period has intermitted, this of August holds out with little change. Observations during the past year indicate no diminution of this phenomena, *five hundred and sixty* different shooting stars being recorded by a party of observers in New Haven, Ct., on the night of August 9th–10th.

On the Luminosity of Meteors. — In an article on this subject, communi-

cated to the *Philosophical Magazine*, April, 1860, by R. P. Gray, the author proposes to show that the luminosity of shooting stars cannot arise from their reflecting the solar light after emerging from the earth's shadow; nor, on the other hand, their sudden disappearance arise from their plunging into that shadow. He enumerates the three current modes of accounting for the luminosity of meteors: first, the aforesaid supposition that they are themselves opaque, but illuminated by solar radiation while exposed to it; secondly, that they are self-luminous, an opinion which all have now nearly abandoned; thirdly, that they become incandescent upon plunging into the earth's atmosphere, either by friction and the enormous condensation which their rapid flight causes, or by absorbing oxygen, and parts of their substance thus becoming chemically changed, and thus exhibiting the usual phenomena of combustion. The author then notices Sir J. Lubbock's paper in the *Philosophical Magazine* for February, 1848, and endeavors to show that ordinary shooting stars would be quite too far off for us to observe such small bodies at even the minimum distance at which, at certain times and places on the earth's surface, we know they can be seen, if merely illuminated by solar light.

M. Julias Schmidt, in a communication recently read before the Imperial Academy, Vienna, urges the importance of greater attention being paid to the tails or luminous trains of light left by luminous meteors in their track, sometimes remaining long after the meteors themselves have disappeared. He considers these observations important: first, as regards their own proper motion; secondly, the downward curvature sometimes exhibited by them, and the way in which they break up and disperse; and, thirdly, the means they may afford of ascertaining by parallax their height above the earth — a matter, too, of importance for determining at what height the atmosphere ceases to have any influence. He observes, that an illustration of these tails or trains may be obtained by throwing from you, quickly or slowly, a lighted lucifer match, when just about to cease to burn; you will perceive either a straight immovable line, or an undulating or a curling line, of whitish-gray smoke standing in the air, if the air be calm or not in motion.

NEW THEORY OF THE FORMATION OF COMETS AND METEORITES.

The following theory, advocating the identity of comets and meteors, has recently been advanced by Reichenbach, the well-known European scientist: "Most meteorites," he says, "can be proved to be an aggregate of distinct particles, inclosed in a dark mass or stroma. Each particle is, as it were, an independent individual, and existed before the inclosing mass did — being an older meteorite inside of a younger, like a fossil shell in chalk. If we conceive a space as large as the comet's tail originally filled with a gaseous substance, in which the atoms of these particles were suspended, and if we furthermore conceive a tendency in these atoms to precipitate and crystallize, it is clear that this process, going on at innumerable points at the same time, milliards of crystals will form, each not much larger than the original atoms, because the matter is taken up synchronously by all neighboring crystals. These crystals by friction and pressure form larger particles, while the unequal distribution of the different elements and the action of their forces will produce at some points denser aggregations than at others, and from this results the phenomenon of one or more 'heads,' or nuclei. The process of condensation may continue, and the nucleus, at the

expense of the tail, may thus become enlarged and finally consolidated, as shown in the compact masses of the meteorites." "Thus is the comet the building material of the meteorite; but a meteorite is a small planet, the destination of which is to unite with a larger planet, to advance by one step the world's process of increase. Thus do we proceed from atoms of matter, isolated in the universe, to smallest crystals, to the cometary tail, to the nucleus of the comet, to the meteorite, and to the planet upon which we walk."

ON THE CONDITION OF THE NUCLEUS OF A COMET, AND THE EVOLUTION FROM IT OF NEBULOUS MATTER.

The following views respecting the constitution of comets are given by Professor W. A. Norton, in a paper published in *Silliman's Journal*, Vol. xxvi., No. 79: —

In the first place, I conceive the telescopic nucleus of a large comet to consist of an atmosphere of aqueous vapor, or of a vaporous and gaseous atmosphere combined, condensed upon an inner nucleus more or less covered with water, or water partly in the condition of ice. In the case of the telescopic comets this central mass is probably altogether wanting. The vaporous atmosphere of the nucleus experiences variations of electric excitement under the influence of the sun, after the same manner that the earth's atmosphere is affected by the sun. That an electric influence is directly exercised by the sun upon the upper regions of the earth's atmosphere, or the photosphere of the earth, appears to me to have been fully established. When repeated electric discharges take place in the higher and rarefied regions of the atmosphere of the comet, or of that of the earth, they must have the effect, according to the results of the recent experiments of M. Plücker, to arrange the vaporous matter in columnar masses, coinciding in direction with the lines of magnetic force. We thus have auroral columns in the comet's as in the earth's atmosphere. At the magnetic poles of the nucleus these would have a vertical position; and from these points would gradually decline from this position, until at the equator they would lie parallel to the surface. Now, as a comet recedes from the sun its temperature falls, the suspended aqueous vapor begins to condense at certain depths in its atmosphere; the electricity thus set free flows in a series of electric discharges, which follow the course of the auroral columns as soon as they are established. Condensations extending through a considerable vertical depth in the upper atmosphere would also be attended with electric discharges from the one elevation to the other. It is these electric discharges along these auroral columns that, as I conceive, disengage the particles of aqueous vapor, or nebulous matter so called, and impel them off with a certain velocity. The same discharges bring the expelled particles into a condition to be repelled by the nucleus. How this result may be produced, cannot here be adequately explained. As the temperature of the receding comet continues to fall, the process of condensation, and consequent evolution of aqueous vapor, goes on, and the visible nucleus increases in size. It would seem, from the observations of Mr. Bond on Donati's comet, that large masses appeared to be disengaged at certain intervals. These phenomena may have arisen from the occasional suspension of the electric discharges taking place in the upper atmosphere. This would produce the appearance of the detachment and expulsion from the surface of the nucleus of a ring of nebulous

matter. Luminous phenomena precisely similar to those here supposed take place in the upper atmosphere of the earth, to which we have given the name of *Aurora Borealis* and *Aurora Australis;* and probably from the same cause. They are almost uninterrupted at the pole during the long polar winter, and only at intervals display their coruscations in the skies of the temperate latitudes, where the changes of temperature are less, and the vaporous columns assume a more oblique position. On the other hand, while a comet is approaching the sun its temperature rises, and at the same time its atmospheric electricity increases; condensations of aqueous vapor and their attendant electric discharges are now much less frequent. It thus happens that the evolution of vaporous matter to form the head and tail is much less copious before than after the perihelion passage, and increases in quantity for a certain interval of time after it. While these auroral phenomena, as they may be styled, are thus subject to great fluctuations, and to sudden interruptions, and are most prevalent in the polar regions[1] of the nucleus, there would seem also to be an uninterrupted electric discharge from all points of the nucleus turned toward the sun, continually detaching particles of aqueous vapor. This should be most abundant at the regions to which the sun is vertical, and where the electric excitement produced by it is the greatest, and may give rise to the hemispherical form of envelope.

The phenomenon of separate concentric envelopes, or rings, often noticed, shows that the vaporous matter set free at any time is not all expelled to the same distance from the nucleus. This would be the case if we were looking down upon the polar regions of a comet whose axis was perpendicular to the plane of its orbit, and the matter was detached in zones from different latitudes. It would seem, also, that different intensities of electrical discharge should be attended with different velocities of projection. Upon the theoretical views I have formed, these electric variations should also give rise to different intensities of repulsive action, as exerted by the nucleus. Again, if all the particles set free should not be of the same size, the smaller ones would experience the greater repulsive acceleration, provided the material repulsion is of the nature of an impulsive action against the surface of the particle.

If the speculative notions just presented be correct, the question arises whether the earth may not be regarded, from our present point of view, as a comet; and if so, why do we not see its luminous train. The proper answer to this inquiry would seem to be, that the earth is actually, in a certain sense, a comet, and that its luminous train is seen by us in the zodiacal light. The nebulous earth-ring contended for by the Rev. Mr. Jones, in explanation of his admirable observations upon the zodiacal light, would seem then, in a modified sense, to have a real existence; instead of being in a condition of statical equilibrium, as supposed, it is in a dynamical condition of perpetual dispersion and renewal.[2]

Nor is the expulsion of vaporous matter into the surrounding regions of space confined to the nuclei of comets and the earth. It occurs at the surface of the sun, and perhaps of all the heavenly bodies. It is beautifully

1 It is to be observed that the motion of the nucleus in its orbit occasions a virtual rotation around an axis perpendicular to the plane of the orbit, so far as exposure to the sun is concerned.

2 The vaporous matter which is incessantly streaming off from the sun into remote space should enhance the brightness of the zodiacal light.

seen as a solar phenomenon in a total eclipse of the sun, in the corona or halo that encircles the sun concealed behind the dark body of the moon, the aigrettes that stream out in various directions, and perhaps also the rose-colored flames that here and there project beyond the dim circular disk of the moon.[1]

Professor Peirce's Views on Comets. —The following statement of views on comets is reported to have been made by Professor Peirce, of Cambridge, to the French Academy; the results being predicated from observations on Donati's comet of 1858:—

The nucleus is of a metallic density, varying from three to twenty, if the density of water be taken as unity, and it is surrounded by an immense atmosphere. Under the influence of the sun's heat, matter is given off from the nucleus, forming an envelope, which rises with uniform velocity. As it rises it becomes electric, like a cloud, and is repelled by the electricity of the sun; and when the solar influence becomes strong enough to overcome the natural cohesive force of the envelope, the latter separates from the comet and becomes the tail. The most electrified particles of the tail are those of the anterior surface; the other particles have much less electricity, the degree depending on their distance from this anterior surface. Prof. Peirce suggests the same explanation (viz., the electrical action) for some of the hitherto unexplained and apparently causeless movements of the heavenly bodies; among others, the erratic movements of Mercury, recently proved by LeVerrier. He states that the nucleus of Donati's comet was less than one hundred and fifty miles in diameter, while the atmosphere had a diameter of forty thousand miles; that the envelope, in that case, rose from the nucleus at the rate of about thirty miles an hour; and that the strength of the electric influence of the sun was such as to destroy gravitation, and give a force repelling the tail from the sun equal to two and a half, if the attraction of gravitation be taken as unity. In that case, however, some of the particles of the tail were so feebly electrified that their repulsive force was overcome by the attraction of gravitation.

Mr. Kemplay's Theory of Comets. —The following theory, brought forward in England by Mr. Kemplay, has at least the merit of novelty. He supposes that a comet is "a body of gaseous matter, homogeneous and indistinguishable in its parts, and nearly, but not perfectly, transparent." The form which a body of this nature, moving, as comets do, round the sun in a very elliptical orbit, would assume under the combined influences of the internal attraction of its particles and the external attraction of the sun, would be that of a prolate spheroid, or oval, with its major axis in the direc-

1 It would seem that even the visible nucleus of a comet is not in a truly statical condition. It contracts and enlarges with the varying distance from the sun. This may be a mere appearance, arising from the varying luminosity of the photosphere. It is also possible that the inner nucleus, with its atmosphere, may be surrounded by an ethereal atmosphere, which contracts and expands by reason of variations in an impulsive action of the sun, and in the density of the ether of space in the vicinity of the sun. These remarks may also apply to the entire envelope of Encke's comet, and the complete spherical envelopes sometimes noticed. Spherical envelopes, entirely surrounding the nucleus, would also be formed, if the cometic matter should be projected from all parts of the nucleus with the same velocity, but with a force insufficient to overcome the gravitating tendency. An apparent spherical continuation of an envelope behind the nucleus might, perhaps, result from the intersections of the orbits of the cometary particles urged past it into space by the repulsive force of the sun.

tion of the line of external attraction. As the body approached the sun, its major axis would increase in length, and it would become more prolate; and as it receded from the sun, the length of its major axis would diminish, and it would approach more nearly to the spherical form. It now remains to reconcile the appearances usually presented by comets with the form which, according to this view, they really possess. This Mr. Kemplay does by supposing that we never see the whole of a comet (the gaseous matter of which it is composed not being luminous in itself), but only such portions of it as are illumined by the sun's rays; the apparent form of the comet being determined by the refractive power of the matter of which it consists. The parallel rays of the sun, falling upon the convex surface of the comet, will converge into a focus, which will generally be within the spheroid, and will then diverge until they reach its further limits. If the mass of the comet be at all of a nebulous or misty character, the course of the refracted rays will be indicated by a luminous appearance; and the degree of brilliancy of any part (supposing the mass to be uniformly nebulous) will depend upon the number of rays passing through that part. The focus will be brightest, and this is the nucleus of the comet; the head, or nebulous envelope of the nucleus, is formed by the converging and diverging rays near the focus, and the tail by the continuation of the diverging rays when they are further dispersed, and shine, consequently, with a feebler lustre.

Such is, briefly, Mr. Kemplay's theory. According to it the tail of a comet ought always to extend in a straight line away from the sun, which is generally, but not always, the case. It explains the fact that the tail is longest when the comet is nearest the sun. The spheroid becomes more prolate as it approaches nearer to the sun, so that the surface on which the rays fall becomes more convex as the comet approaches its perihelion; and the more convex the surface, the shorter the focus, and consequently the longer the diverging rays. As the comet recedes from the sun its surface becomes less convex, and the focus gradually longer, until at last it falls beyond the limits of the spheroid, and the comet is no longer visible. The sudden disappearance of Halley's comet in 1836 may be accounted for in this way. The backward curvature of the tail, which is frequently observed when the comet is near its perihelion, is explained by the inclined position which the comet assumes at that period, owing to its parts which are farthest from the sun (the tail) having to pass through a much larger space in the same time than the parts nearest the sun (the nucleus). The fact that the sides of the tail are more brilliant than the centre, Mr. Kemplay attributes to the convergence of more rays at the sides than in the centre, and illustrates his explanations by diagrams. The streaming light which occasionally shoots along the tail with inconceivable rapidity he accounts for by an undulation in the whole mass of the comet, producing an effect analogous to that observed in a field of corn when shaken by the wind.

The above are the principal cometary phenomena of which Mr. Kemplay's theory offers a consistent explanation. Those which are inconsistent with it are, principally, the occasional appearance of a shorter and wider tail, extending on each side of the original tail, and varying in position; the occasional appearance of the tail at right angles to a line drawn from the sun; and the fact that, when stars are seen through comets, no refraction of their rays is observed. The first of these facts Mr. Kemplay can only account for by supposing that the particular comets in which it was observed were subjected at the time to some peculiar disturbing influence, which modified

their prolate spheroid form. The last two he is inclined to attribute to imperfect or prejudiced observation, observing that "in matters of scientific speculation the owner of a favorite theory is prone to take great liberties with things unknown."

ACCELERATION OF THE MOON'S MOTION.

A curious controversy has lately arisen on the subject of the acceleration of the moon's motion, which is now exciting great interest among mathematicians and physical astronomers. Professor Adams and M. Delaunay take one view of the question, MM. Plana, Pontécoulant, and Hansen, the other. Mr. Airy, Mr. Main, the President of the Astronomical Society, and Sir John Lubbock, support the conclusions at which Professor Adams has arrived. The question in dispute is strictly mathematical; and it is a very remarkable circumstance in the history of astronomy that such great names should be ranged on opposite sides, seeing that the point involved is really no other than whether certain analytical operations have been conducted on right principles; and it is a proof, therefore, if any were wanting, of the extraordinary complexity and difficulty of these transcendental inquiries. The nature and facts of the controversy are thus stated by Professor Airy, the Astronomer Royal of England, in a recent paper before the Astronomical Society:—

It has been known from the time of Newton that the motions of the moon are disturbed by the attraction of the sun, and that a great part of the effect is of the following kind, viz., that when the moon is between the sun and the earth, the sun attracts the moon away from the earth; and when the earth is between the sun and the moon, the sun attracts the earth away from the moon; and thus, in both cases, it tends to separate the earth and the moon, or diminishes the attraction of the moon to the earth. There are sometimes effects of the opposite character; but, on the whole, that just described is predominant. If this dimunition were always the same in amount, the periodic time of the moon passing round the earth would always be the same. But it was found in the last century, by Halley and Dunthorne, that the periodic time is not always the same. In order to reconcile the eclipses of the moon recorded by Ptolemy with modern observations of the moon, it was necessary to suppose that in every successive century the moon moves a little quicker than in the preceding century, in a degree which is nearly represented by supposing that at each successive lunation the moon approaches nearer to the earth by one inch. The principal cause of this was discovered by Laplace. First, it had been shown by him and by others that the attractions of the other planets on the sun and on the earth do not alter the longer axis of the orbit which the earth describes round the sun, and do not alter the length of the year; but they diminish slowly but continually through many thousands of years the degree of ellipticity of the earth's orbit. Now, when the earth is nearest to the sun, the decrement of attraction of the moon to the earth (mentioned above) is greatest; and when the earth is furthest from the sun, that decrement is least. It had been supposed that the fluctuations of magnitude exactly balance. But Laplace showed that they do not; he showed that the increased amount of decrement (when the earth is nearest the sun) overbalances the diminished amount (when the earth is furthest from the sun); and, therefore, that the less eccentric is the earth's orbit the less does the increased amount of decrement at one part

overbalance the diminished amount at another part, and the less is the total amount of the sun's disturbing force. And as the sun's disturbing force diminishes the moon's attraction to the earth, that attraction is less and less impaired every century, or becomes practically stronger; every century the moon is pulled into a rather smaller orbit, and revolves in a rather shorter period. On computing the effect from this cause, it was found to agree well with the effect which Halley and Dunthorne had discovered in observations. The lunar tables thus amended, and with other but minor improvements, were applied to the computation of other ancient eclipses, which require far greater nicety than Ptolemy's lunar eclipses, namely, total eclipses of the sun. The most remarkable of these were the eclipse of Thales (which occurred at a battle), that at Larissa, or Nimrúd (which led to the capture of that city by the Persians from the Medes), and that of Agathocles (upon a fleet at sea). They are all of great importance in settling the chronology. Dates were thus found for these several eclipses, which are most satisfactory. About this time Mr. Adams announced his discovery, that a part of the sun's disturbing force had been omitted by Laplace. The sun pulls the moon in the direction in which she is going (so as to accelerate her) in some parts of her orbit, and in the opposite direction (so as to retard her) in other parts. Laplace and others supposed that those accelerations and retardations exactly balance. Mr. Adams gave reason for supposing that they do not balance. In this he was subsequently supported by M. Delaunay, a very eminent French mathematician, who, making his calculations in a different way, arrived at the very same figures. But he is opposed by Baron Plana, by the Count de Pontécoulant, and by Professor Hansen, who all maintain that Laplace's investigations are sensibly correct. And in this state the controversy stands at present. It is to be remarked, that observations can here give no assistance. The question is purely whether certain algebraical investigations are right or wrong. And it shows that what is commonly called "mathematical evidence" is not so certain as many persons imagine, and that it ultimately depends on moral evidence. The effect of Mr. Adams's alteration is to diminish Laplace's change of the periodic time by more than one-third part. The computations of the ancient eclipses are very sensibly affected by this. At present we can hardly say how much they are affected; possibly those of Larissa and Agathocles would not be very much disturbed; but it seems possible that the computed eclipse of Thales might be thrown so near to sunset as to be inapplicable to elucidation of the historic account. This is the most perplexing eclipse, because it does not appear that any other eclipse can possibly apply to the same history. The interest of this subject, it thus appears, is not confined to technical astronomy, but extends to other matters of very wide range. And the general question of the theory of the moon's acceleration may properly be indicated as the most important of the subjects of scientific controversy at the present time.

ON THE SECULAR PERTURBATIONS OF FOUR OF THE ASTEROIDS.

The following is a reported abstract of a paper on the above subject presented to the American Association for the Promotion of Science by Mr. S. Newcomb, of Cambridge: —

Dr. Olbers supposed that the numerous small planets circulating between Mars and Jupiter were the fragments of a large one which had been shattered through the agency of some unknown cause. If this hypothesis were

true, the orbits during several hundred years would all pass very near the point where the explosion occurred, but after thirty thousand years the orbits would have changed so much that no trace of this intersection would be left. Consequently, if this explosion occurred at any time within the last three millions of years, the fact that the orbits do not now intersect is no argument against Olbers' hypothesis.

The best way to treat the problem was to make actual calculations as exact as possible of the positions of the orbits during all time. We can then easily see whether they could have ever intersected. These calculations were made by Mr. N. for the four asteroids, Vesta, Metis, Hygea and Parthenope.

If the changes we now see going on in the orbits of the planets were to continue long enough, they would finally lead to the destruction of the solar system, by causing the earth and planets to fall into the sun. But mathematical investigations showed that these changes, after tens of thousands of years, will cease, and the orbits will begin to return to their present state, and will never do more than oscillate between narrow limits; these oscillations occupying from fifty thousand to half a million of years. They were illustrated by a chart exhibiting all the changes in the eccentricity of Vesta during the last five hundred thousand years.

The next question was whether the orbits of Vesta and Hygea could ever have intersected, and this was answered in the negative. The mean distance of Hygea is much greater than that of Vesta, and all but one of the terms in the rigorous expressions for the eccentricity are nearly the same for both planets. The consequence of this is that whenever the orbit of Vesta is elongated in a particular direction, that of Hygea will be elongated in the same direction, and will thus recede from it. Actual calculation showed that they could never have come within much less than thirteen millions of miles of each other. It does not, therefore, seem that Olbers' hypothesis can be true, unless some force of which we have no knowledge has acted on these planets.

DRY FOGS.

These phenomena have been lately much discussed by the meteorologists of France. The Abbé Moigno states that these fogs are seen in Belgium and Holland from April to the beginning of June, when the wind is in the northwest, north, or northeast, after the sun has shone for several days. Their appearance coincides generally with a temperature above the mean, but not constantly. They disappear and return again, sometimes after eight days. They do not seem to extend to a great height in the atmosphere, and disappear when the wind becomes strong, or when the air is highly charged with humidity. M. Vercruysse, of Courtrai, considers the origin of these fogs may be found in the masses of vegetable matter which cover the shores of Holland and Belgium to a considerable depth. These masses engender grayish-blue vapors, through which the sun appears, especially in the evening, of a fiery hue, and which the north wind disperses to a great distance over the country. In 1783, a thick dry fog extended over a great part of Europe. It did not moisten the ground, and appeared like a thick smoke. The sun was so much obscured by it, especially in the morning, that at eight o'clock, when it had well risen, it had to be searched for. During the rest of the day the fog was more elevated. It remained immovable, in spite of the winds and storms which raged above it, and lasted a month, or from June 20th to July 20th. For this phenomenon no satisfactory explanation has ever been given. It was, however, referred by some to the great earthquakes

which occurred in the early part of the same year in Calabria and Iceland. The harvests of the year did not in any way appear to be affected by it.

DUST STORMS, AND THE "SIMOON" OF INDIA.

At a recent meeting of the British Meteorological Society, Dr. H. Cook, in a paper on "Dust Storms, Dust Columns, and the Simoon, or Poisonous Wind of India," remarked that there are certain days in which, however hard and violently the wind may blow, little or no dust accompanies it; whilst at other times every little puff of air or current of wind raises up and carries with it clouds of dust; and at these times the individual particles of sand appear to be in such an electrified condition that they are even ready to repel each other, and are, consequently, disturbed from their position and carried up into the air with the slightest current.

To so great an extent does this sometimes exist, that the atmosphere is positively filled with dust, and, when accompanied by a strong wind, nothing is visible at a few yards, and the sun at noonday is obscured. This condition of the atmosphere is evidently accumulative. It increases by degrees until the climax is reached, when, after a certain time, usually about twenty-four hours, the atmosphere is cleared and equanimity is restored.

Dust columns appear under a similar condition of electrical disturbance or intensity. On calm, quiet days, when hardly a breath of air is stirring, and the sun pours down his heating rays with full force, little circular eddies are seen to arise in the atmosphere, near the surface of the ground. These increase in force and diameter, and usually remain stationary for some time, and then sweep away across the country at great speed; and ultimately lose gradually their velocity, dissolve, and disappear.

The author had seen, in the Valley of Murgochow, which is only a few miles across, and surrounded by high hills, on a day when not a breath of air stirred, twenty of these columns. These seldom changed their position, or but slowly moved across the level tract, and they never interfered with each other.

The author then spoke of the simoon, — that deadly wind which occasionally visits the deserts of Cutchee and Upper Sind, — which is sudden, and singularly fatal in its occurrence, invisible, intangible, and mysterious. Its nature is alike unknown (as far as the author is aware) to the wild, untutored inhabitant of the country it frequents, as to the European man of science; its effects only are visible. Its presence is made known in the sudden extinction of life, whether animal or vegetable, over which its influence has extended. The author gives the results of his information respecting the simoon, as follows: —

1. It is sudden in its attack. 2. It is sometimes preceded by a cold current of air. 3. It occurs in the hot months (usually June and July). 4. It takes place by night as well as by day. 5. Its course is straight and defined. 6 Its passage leaves a narrow, "knife-like" tract. 7. It burns up or destroys the vitality of animal and vegetable existence in its path. 8. It is attended by a well-marked sulphurous odor. 9. It is described as being like the blast of a furnace, and the current of air in which it passes is greatly heated. 10. It is not accompanied by dust, thunder, or lightning.

The author concluded his paper by asking, If, then, it be neither a phase of sun-stroke, lightning, malaria, nor miasmata in a concentrated form, what is it, or to what is it to be referred?

TABLE OF GEOGRAPHICAL POSITIONS, DETERMINED FROM ASTRONOMICAL OBSERVATIONS, BY BREVET LIEUTENANT-COLONEL J. D. GRAHAM, U. S. CORPS TOPOGRAPHICAL ENGINEERS, DURING THE YEARS 1857, 1858, AND 1859.

Many of the tables of the latitudes and longitudes of places in the United States are made up by mixing, indiscriminately, the results announced by astronomers and geographers, with the imperfect ones which are derived from measurements, with the dividers, upon the most convenient maps within reach, without in any case giving credit or authorities. This is a great injustice to a class whose labors are prosecuted through many a sleepless night, often amidst severe exposures to the weather and climate incident to our vast extent of territory, solely in pursuit of those truths upon which its accurate geographical delineation must depend.

The accompanying table, therefore, of latitudes and longitudes of places in the West, derived from recent astronomical observations made by Lieutenant-Colonel Graham, U. S. A., will, it is believed, from their undoubted accuracy, be regarded as a valuable contribution to American geographical statistics. —*Ed.*

No. for reference.	Positions.	State.	North Latitude.	Longitude West of the Meridian of Greenwich. In Arc.	Longitude West of the Meridian of Greenwich. In Time.
			° ′ ″	° ′ ″	h. m. s.
1	Albany (sometimes called New Albany). The intersection of Maple and Main Sts., .	Ill.	41 47 20.30	90 13 28.95	6 00 53.93
2	Armstrong (Fort). On lower end of Rock Island, ...	Ill.	41 30 59.80	90 33 49.80	6 02 15.32
3	Ashtabula. Centre of the North Public Square, or Park, .	Ohio.	41 52 04.00	80 47 23.25	5 23 09.55
4	Camanche. Intersection of Main and Maxan Streets, . .	Iowa.	41 46 58.90	90 15 06.60	6 01 00.43
5	Camanche. Flag-staff on Chicago Street, about one hundred yards west of the shore of the Mississippi River, . .	Iowa.	41 46 51.30	90 15 11.10	6 01 00.74
6	Chicago. Steeple of the Roman Catholic Church of The Holy Name, on Wolcott Street, between Huron and Superior Streets, . . .	Ill.	41 53 48.00	87 37 44.25	5 50 30.95
7	Chicago. The dome of the City Hall or Court House, . .	Ill.	41 53 06.20	87 37 57.75	5 50 31.85
8	Chicago. The new Iron Light House, erected by Lieut.-Colonel J. D. Graham, at the east end of the north harbor pier, first lighted June 29th, 1859.	Ill.	41 53 24.90	87 36 55.50	5 50 27.70
9	Chicago. The old Stone Light House on the south bank of Chicago river, near River Street, ...	Ill.	41 53 22 50	87 37 35.32	5 50 30.35
10	"City of Rock Island." The centre of Washington Square (called on some of the older maps "Church Square"),	Ill.	41 30 37.80	90 34 13.95	6 02 16.93
11	"City of Rock Island." Dome of the Court House on Orleans Street, between Elk and Deer Streets, ...	Ill.	41 30 33.70	90 34 38.85	6 02 18.59

No. for reference.	Positions.	State.	North Latitude.			Longitude West of the Meridian of Greenwich. In Arc.			In Time.		
			°	′	″	°	′	″	h.	m.	s.
12	Cleveland. The new Court House, ...	Ohio.	41	30	05.00	81	42	02.55	5	26	48.71
13	Cleveland. The Light House on the hill, ...	Ohio.	41	30	07.60	81	42	28.05	5	26	49.87
14	Cleveland. The Beacon Light at the lakeward end of the U. S. harbor pier, . . .	Ohio.	41	30	16.50	81	42	57.60	5	26	51.84
15	Columbus, the State Capital. The Dome of the Capitol, . .	Ohio.	39	57	43.20	83	00	04.35	5	32	00.29
16	Davenport. The Court House,	Iowa.	41	31	24.80	90	34	40.05	6	02	18.67
17	Dubuque. Centre of the city, as now built, ...	Iowa.	42	29	55.00	90	39	56.55	6	02	39.77
18	Dunleith. The Passenger House of the northwestern terminus of the Illinois Central Rail Road, ...	Ill.	42	29	42.50	90	38	53.55	6	02	35.57
19	Elyria. The Dome of the Court House, ...	Ohio.	41	22	01.25	82	06	48.90	5	28	27.26
20	Erie. Steeple of the Court House,	Penn.	42	07	49.30	80	05	41.70	5	20	22.78
21	Erie. The Light House, . . .	Penn.	42	08	42.70	80	04	12.25	5	20	16.81
22	Erie. The Beacon Light at the lakeward end of the U. S. West Pier, ...	Penn.	42	09	16.70	80	05	04.05	5	20	20.27
23	Erie. Passenger House at the Depot of the Erie and Buffalo Rail Road, ...	Penn.	42	07	19.80	80	05	18.15	5	20	21.21
24	Erie. Stone monument (placed by the late Professor Andrew Ellicott) at the west corner of Parade and Front Streets, inscribed, "1795, Lat. 42° 08′ 14″. Var. 0° 43′ E.", ...	Penn.	42	08	20.81	80	05	13.80	5	20	20.92
25	Fulton. Intersection of the middles of Base and Cherry Streets, ...	Ill.	41	52	08.00	90	09	59.55	6	00	39.97
26	Fulton. The foot of Cherry Street, on the east bank of the Mississippi River, ...	Ill.	41	52	08.00	90	10	11.70	6	00	40.78
27	Lyons. Intersection of the middles of Exchange and Third Streets, ...	Iowa.	41	52	15.00	90	10	38.55	6	00	42.57
28	Lyons. The Turret of the Female Institute, ...	Iowa.	41	52	10.51	90	11	11.10	6	00	44.74
29	Madison, the Capital of Wisconsin. The Dome of the State Capitol, ...	Wis.	43	04	30.80	89	23	12.30	5	57	32.82
30	*Marais des Osiers*. The west end of the ferry, on the Albany and "City of Rock Island" Stage Road, ...	Ill.	41	46	11.62	90	14	55.05	6	00	59.67
31	Michigan City. Centre of the Public Square, ...	Ind.	41	43	08.33	86	54	19.95	5	47	37.33
32	Michigan City. The Light House,	Ind.	41	43	22.88	86	54	29.10	5	47	37.94
33	Michigan City. Passenger House of the Michigan Central Rail Road Company's Station, ...	Ind.	41	43	18.91	86	54	23.34	5	47	37.55
34	Michigan City. Intersection of Franklin and Michigan Streets (centres), ...	Ind.	41	43	11.23	86	54	18.00	5	47	37.20
35	Milwaukee. Dome of the Court House, ...	Wis.	43	02	34.61	87	54	22.05	5	51	37.47
36	Milwaukee. Steeple of the Roman Catholic Church on Jackson Street, ...	Wis.	43	02	33.70	87	54	19.05	5	51	37.27

No. for reference.	Positions.	State.	North Latitude.			Longitude West of the Meridian of Greenwich. In Arc.			In Time.		
			°	′	″	°	′	″	h.	m.	s.
37	Milwaukee. The Light House, situated near the foot of Wisconsin Street, on the high bank of the lake shore,	Wis.	43	02	24.00	87	54	04.05	5	51	36.27
38	Milwaukee. The Beacon Light at the east end of the north harbor pier, ...	Wis.	43	01	37.00	87	53	55.80	5	51	35.72
39	New Buffalo. Intersection of the middles of Whittaker Avenue and Mechanics Streets,	Mich.	41	47	47.00	86	44	53.55	5	46	59.57
40	New Buffalo The Light House,	Mich.	41	47	43.50	86	45	33.90	5	47	02.26
41	Niles. Intersection of Main and Fourth Streets, ...	Mich.	41	49	54.00	86	15	37.80	5	45	02.52
42	Niles. Steeple of Trinity Church (Episcopal), at the southeast corner of Broadway and Fourth Streets, ...	Mich.	41	49	46.10	86	15	36.60	5	45	02.44
43	Niles. Foot of Main Street, on the east bank of St. Joseph River, ...	Mich.	41	49	54.00	86	15	54.30	5	45	03.62
44	Prairie du Chien. Telegraph office at the western terminus of the Milwaukee and Mississippi Rail Road, on the left, or east bank of the Mississippi River, ...	Wis.	43	02	00.15	91	08	35.25	6	04	34.35
45	Racine. Dome of the Court House, ...	Wis.	42	43	44.60	87	47	00.55	5	51	08.03
46	Racine. The Tower of St. Luke's Church (Episcopal), . .	Wis.	42	43	45.40	87	46	57.55	5	51	07.83
47	Toledo. Intersection of Jefferson and Superior Streets (centres).	Ohio.	41	39	01.57	83	32	21.75	5	34	09.45
48	Toledo. The Rail Road Depot, Ticket office, ...	Ohio.	41	38	47.04	83	32	14.40	5	34	08.96
49	Waukegan. Dome of the Court House, ...	Ill.	42	21	43.70	87	50	07.20	5	51	20.48
50	Waukegan. Intersection of Madison Street with the shore of Lake Michigan, . . .	Ill.	42	21	44.20	87	49	36.50	5	51	18 43
51	Waukegan. The Light House,	Ill.	42	21	29.30	87	49	56.55	5	51	19.77

The foregoing positions are all derived from astronomical observations, carefully made, with good instruments.

The following additional positions are given as approximations, near enough for general geographical purposes, such as the projection of maps, etc.

They are derived from measurements of courses and distances,— made on C. H. Stoddard's map of Scott County, Iowa, and Rock Island County, Illinois, published in 1857,— from our astronomical station in the centre of Washington Square, in the "City of Rock Island," Illinois. See No. 10 in the Table.

The said map is, we believe, compiled from the United States public land surveys.

No. for reference.	Positions approximately determined.	State.	North Latitude.	Longitude West of the Meridian of Greenwich. In Arc.	In Time.
			° ′ ″	° ′ ″	h m. s.
52	Moline. The south end of the bridge connecting with Rock Island, ...	Ill.	41 30 37.00	90 30 46.05	6 02 03.07
53	"Rock Island City." On Rock River, ...	Ill.	41 28 14.30	90 35 02.55	6 02 20.17
54	Rock River, at its mouth in the Mississippi River. Point of reference: The west extremity of the island in the mouth of Rock River, . .	Ill.	41 29 01.30	90 35 49.05	6 02 23.27
55	Watertown. On the left shore of the Mississippi River, . .	Ill.	41 32 19.60	90 24 58.05	6 01 39.87

OBITUARY

OF PERSONS EMINENT IN SCIENCE. 1860.

Bevan, Dr. Edward, an English entomologist, best known for his studies on the bee.

Boydell, James, inventor of Boydell's steam-plough.

Browne, Peter B., a lawyer of Philadelphia, best known in science for his microscopical researches on hair.

Brisbane, General Sir Thomas, an astronomer of repute; President of the Royal Society of Edinburgh.

Bunsen, Chevalier, of Prussia.

Condie, J., of Scotland, inventor of the steam-hammer.

Daussy, Pierre, an eminent French hydrographer.

Dent, Frederic, an eminent clock-maker, of London.

Dumeril, M., a French naturalist.

Ellis, Robert Leslie, an eminent English mathematician.

Espy, James P., the celebrated meteorologist.

Goodyear, Charles, inventor of "vulcanized India-rubber."

Grimm, William, the celebrated German philologist.

Gmelin, Christian, a well-known German chemist and author.

Hausmann, Jean F., an eminent European mineralogist.

Holmes, Dr. William P., a well-known botanist and mineralogist, of Canada.

LeConte, John, Vice President of the Academy of Sciences, Philadelphia.

Locke, Joseph, an eminent English engineer.

Owen, David Dale, a well-known American geologist.

Payer, Jean Baptiste, a French botanist.

Poinsôt, M., an eminent French mathematician.

Powell, Baden, of Oxford, England.

Retzius, Professor, a German archæologist.

Robiquet, Edmond, Professor Physics L' Ecole de Pharmacie, Paris.

Roscher, Dr., an African explorer, murdered by the natives of the East Coast.

Spence, William, an English entomologist.

Symonds, Jelinger C., a well-known English educational reformer and scientific amateur.

Todd, Dr., an eminent English physiologist.

Webster, W. F., late Professor of Chemistry, Washington College, Pa.

Wirtemberg, Paul, Duke of, an eminent naturalist.

Wurdemann, Gustavus, a naturalist and physicist, long attached to the U. S. Coast Survey.

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Anthony, J. J. Descriptions of New Species of American Fluviatile Gasteropods. 8vo. pamphlet.

Barbee, Dr. W. J. The Physical and Moral Aspects of Geology. Philadelphia: Challen & Son.

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Binney, W. G. Catalogue of the Terrestrial and Fluviatile Gasteropods inhabiting North America. 8vo. pamphlet. Boston. 1860.

Blake, W. P. and C. T. Jackson. The Gold Placers of the vicinity of Dahlonega, Ga.

Brush, George J. Eighth Supplement to Dana's Mineralogy. 8vo. tract.

Buckland, F. T. Curiosities of Natural History. First and Second Series. New York: Rudd & Carleton.

Chapman, Dr. A. W. Flora of the Southern States. New York: Ivison & Phinney.

Cooke, Prof. J. L., Jr. Elements of Chemical Physics. 8vo. pp. 739. Boston: Little & Brown.

Coultas, Harland. What may be learned from a Tree. 8vo. pp. 190. D. Appleton & Co.

Cowes, Samuel E. Study of the Earth. 4to. pp. 98.

Dawson, J. W. On Fossil Plants from the Devonian Rocks of Canada. 8vo. tract.
" On the Silurian and Devonian Rocks of Nova Scotia. 8vo. tract.
" On the Vegetable Structures in Coal. 8vo. tract.

Day, Dr. George E. Chemistry in its relations to Physiology and Medicine. With numerous illustrations. New York: Ballière Brothers. 8vo. pp. 318. $5.00.

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Faraday, Michael. A Course of Six Lectures on the Various Forces of Matter, and their Relations to Each Other. With illustrations. New York: Harper & Brothers. 12mo. pp. 198.

Ferrel, William. The Motions of Fluids and Solids relative to the Earth's Surface; comprising Applications to the Winds and Currents of the Ocean. New York: Ivison & Phinney.

French and Smith. New York State Gazetteer and Map (including a Geological and Meteorological Chart of the State of New York). Syracuse, N. Y.

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Gesner, Abraham, M. D. A Practical Treatise on Coal, Petroleum, and other Distilled Oils. New York: Ballière Brothers. 8vo. pp. 184.

Gibbon, Capt. John, U. S. A. The Artillerist Manual. Illustrated. 8vo. pp. 568.

Gibbs, L. R. Rules for the Accentuation of Names in Natural History. 4to. pamphlet.

Gibbs, L. R. Past and Present Condition of Niagara Falls. Pamphlet. 1860.

Gosse, P. H. Romance of Natural History. With numerous illustrations. Boston: Gould & Lincoln.

Graham, Col. J. D., U. S. A. On the Latitude and Longitude of Milwaukee, Prairie du Chien, Racine, and Madison, Wis. Pamphlet; from the 4th vol. of the Proc. Wisconsin Historical Society.

Hall, T. J. Additions to the Flora of Wisconsin. 8vo. tract.

Hayden, F. V. Geological Sketch of the Estuary, etc., of the Judith River; also, Extinct Vertebrata from Judith River and the great Lignite Formations of Nebraska, by Joseph Leidy. 4to. pamphlet.

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